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Effect of Immersive Virtual Reality Environment on Reaction Time, Agility and Coordination among Collegiate Students

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ABSTRACT

Background: Virtual reality is the sum of the hardware and software systems that seek to perfect an all-inclusive, sensory illusion of being present in another environment which is applied to a broad range of sports such as skiing, goalkeeping rugby union, baseball and basketball, pistol shooting and cycling speed. Reaction time is the elapsed time between stimulus onset and an individual's response on elementary cognitive tasks. Coordination is the capability to perform a sequence of movements rhythmically smoothly and accurately. Agility refers to the capacity to quickly change the location of the entire body in space with quickness and accuracy

Objectives: The main objective of this study was to see the effect of virtual reality table tennis on coordination, reaction time and agility among collegiate students.

Material and Methods: Based on inclusion and exclusion criteria, 60 collegiate students of age group 18-24 years were taken. The subjects were divided into two groups as group A and group B of 30 each. Group A played table tennis game in real environment and group B played table tennis in virtual environment. Pre and post score were taken for coordination, reaction time and agility using hand eye coordination test, plate tapping test and Davies test respectively. The data was collected, compiled and analyzed.

Result:Descriptive statistics, paired & unpaired 't' test were used for the intra-group and intergroup comparison. Significant improvements were seen in post scores of coordination, reaction time and agilityin both groups at 0.05 level in both real and virtual table tennis groups. However, when both groups were compared, non-significant differences were observed in all the variables.

Conclusion:The study concluded that virtual reality table tennis is as effective as real table tennis in improving reaction time, coordination and agility among collegiate students.

Keywords: Virtual Reality, Table Tennis, Coordination, agility, Reaction Time.

INTRODUCTION

Developments in technology in the 21st century have increased by speeding the advancement of apps and software and making it easier to access all kinds of information but do have its demerits. Technology should not replace effective teaching but should be viewed as a supplement to appropriate pedagogical practices. One of the innovations of technology that began to appear in the past few years is'virtual Reality (VR)'. VR can immerse individuals in an atmosphere that would normally be inaccessible because of cost, danger, or restrictions.[1]

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In virtual reality (VR), computer images are utilized to simulate a realistic environment that responds to users.This environment is widely used in various industries due to its adaptability, dependability and variety.Thus, VE integrates reality with imagination and creates an environment that is akin to the one in which we move and live.[4]

This article focuses to see the effect of virtual reality gaming on the general physical fitness and performance coordination, reaction time and agility. Coordination is the capability to perform a sequence of movements rhythmically smoothly and accurately. It involves the sense of body, muscular contraction and joint movement of the body.[5] Agility refers to capacity to quickly change the location of the entire body in space with quickness and accuracy.[6] Reaction time refers to the time elapsed between stimulation and the beginning of the response to it.[6]

Any technique for improving or promoting physical activity is worthwhile researching in a society that is overweight and where obesity and inactivity are the fifth major causes of worldwide health.[7] The newest statistics show that Asia has more gamers than any other region (1.48 billion), thus it is crucial to investigate this topic to make it useful. Hayes and Silberman in 2007 discussed that video games are an underutilised tool for increasing young people's excitement and capacity to participate in sports and other movement-based activities.[8]However, their proposed model did not account for the need for physical movement when playing these games, which is provided by virtual reality-based gaming, that provides the full experience and refutes the notion that playing video games encourages a sedentary lifestyle.VR has been applied to a broad range of sports such as skiing, goalkeeping, baseball, basketball, pistol shooting and cycling. It can be considered an excellent tool to improve the quality and speed of learning and developing skills.[3]

It has a satisfactory effect on various aspects of sports rehabilitation such as attention deficits, spatial perception disorders, memory disorders in cognitive rehabilitation, anxiety, depression, phobia in emotional disorders, akinesia, chorea in mental diseases etc.[9]But this article focuses on the effect of virtual reality table tennis game on physical variables of fitness using table tennis game which is one of the most popular sport in the world, that requires complex spatial movements of the body like acceleration, deceleration, direction change, moving quickly and balance all helping players generate optimum stroke production.[10]

MATERIAL AND METHODS

Study Design: The study was an experimental study, which was comparative in nature.

Research settings: In and around Ludhiana

Sample Size: 60 subjects

Sampling technique: The sample of the study was selected by purposive sampling.

Study period: The study was completed in 10 months from June 2022 to April 2023.

Eligibility

Inclusion Criteria

- Subjects between age group of 18-25 years
- Both males and females were taken
- Subjects who were not involved in any routine sports training and conditioning program
- Recreational table tennis players who were familiar with the game for atleast 1 year
- Subjects with BMI ≤ 25

Exclusion Criteria

- Subjects with any soft tissue injury order formity
- Subjects with severe musculoskeletal, neural, somatic,and psychiatric conditions.
- Subjects involved in any recent strengthening programme.
- Non cooperative subjects.

Procedure

Based on inclusion and exclusion criteria, subjects with at least 1 year of table tennis experience who were not undergoing any strength training programme or suffering from any injury were taken. After that their height

and weight were measured to calculate their BMI using the formula, weight in kilograms divided by height in metres squared. 60 subjects with normal BMI were selected by purposive sampling and informed consent was taken. Subjects were divided into 2 groups with 30 subjects in each group. Group A and B played table tennis in real and virtual environment respectively.

Pre score for reaction time, coordination and agility through plate tapping test,hand eye coordination test and Davies test respectively were collected for all the participants. The participants were given time for familiarization.

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1. Hand eye coordination test

This test was used to measure the co-ordination between eye and hand. One line was marked two meter away from the wall. Subjects start the test from starting line. On the signal of start, subject threw the ball against the wall and caught the ball with the other hand, after he caught it, he threw the ball with that hand and caught it with the other hand. This process continued for the 30 second. After 30 seconds, the timer gave the signal to stop and the numbers of correctly made catches were recorded.[5]

2. Plate tapping test

It was used to calculate the reaction time of an individual. The subject tried to touch 2 disks with the preferred hand in defined order in a fast way. Two 20-cm disks were placed on a table. The distance between the two disks to each other was 80cm (the edges are 60-cm to each other). 10 x 20cm rectangular plate was placed to an equally far area to both disks. The best score was considered as the final point. The point was the time used to touch each disk 25 times.[11]

2. Daviestest

The Davies test (DT) was used to assess upper body agility and stabilization.

Two pieces of tape were placed 36 inches apart on the ground. The participant started the test in a push-up position with one hand on each piece of tape. The participants were then asked to quickly touch their right hand with the left hand and continue to perform alternating touches on each side for 15 seconds. The number of touches by both hands were recorded.[12]

Group A included 30 subjects who played table tennis in real environment. The table tennis setup included a regular size table tennis table, two table tennis bats and 40mm table tennis balls. Two subjects were made to play at once with all the rules and regulations followed as set by the International Table Tennis Federation.The subjects were made aware of the techniques and rules at the beginning and all the subjects played under proper supervision as shown in figure 1. Protocol was given for 3 sessions in a week for 4 weeks.

Group B included 30 subjects who play Table tennis through VR. They were made to play “Ping-Pongpro”game on Sony Play Station 4. This game required the users to inter act by moving and responding to incoming stimuli. Subjects are armed with a singular paddle and face opponents. The Game started with a brief tutorial explaining all the mechanics and allows to adjust a multitude of settings to your liking from the height of the table, angle of the paddle and its position in player’s hand.The subject had to choose from 5 different stages and play against the computer with a wide range of difficulty settings allowing him to face the easiest of foes to some next level opponents in some very lively surroundings like a rather larger arcade, a busy neighbourhood, park, gymnasium and 1 or 2 more with each looking busy and alive.

They played on a PSVR setup that included Play Station 4 console, VR headset, Play Station camera, dual shock 4 wireless controllers, two Play Station move motion controllers, screen, ear phones. Subjects wore the headset and used one move motion controller in the dominant hand as table tennis racquet and other one was used to control the table tennis ball in the game, held in other hand. The subject’s movement of head and motion controller was captured and

Fig.1: Subjects playing table tennis in real environment

Fig. 3: Subject playing Ping pong pro game on PSVR

interpreted through the PS4 camera. The game was played against the AI opponent, according to the official table tennis rules. The difficulty of the AI ranged across five levels which differed with increase in speed of serve and returns, spins on ball from AI etc. After each game of 3 sets of 11 points, another

Fig. 2: VR Play Station 4 Setup

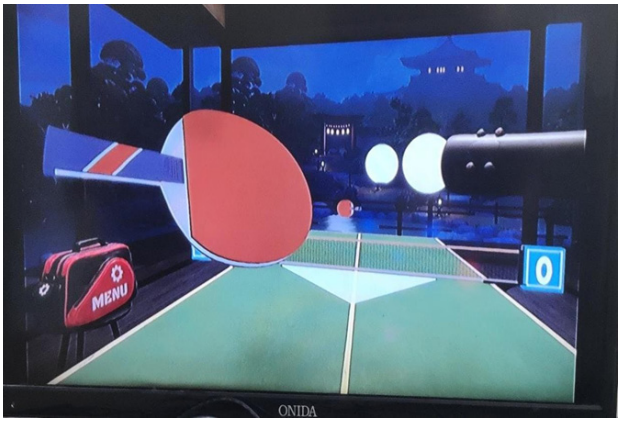

Fig. 4: VR Play Station 4 Setup

commenced. Subjects were given a familiarization session at the beginning to make them understand the task and to get them adapted to the virtual environment. Each session was given under full supervision as shown in figure 2. Protocol was given for 3 sessions per week for 4 weeks.

After 4 weeks of intervention, the post scores for reaction time, coordination and agility were collected for all the participants of group A and B. The pre and post scores for all the variables were the compiled and analyzed.

Statistical Analysis

The data was analyzed using descriptive statistics, paired 't' test and unpaired 't' test. Paired 't' test was used for intra group analysis and unpaired 't' test for inter group analysis.

RESULT

TABLE 1: Paired 't' test results for intragroup comparison for both group A and B

INTRAGROUP COMPARISON		Group A		Group B	
		PRE	POST	PRE	POST
HAND EYE COORDINATION	Mean	15.40	18.30	17.73	21.13
	SD	5.373	5.194	6.502	6.882
	t- value	5.83		6.18	
	p- value	<0.001*		<0.001*	
	Significance	Significant		Significant	
REACTION TIME	Mean	13.75	10.01	13.36	10.00
	SD	3.151	2.885	2.965	2.309
	t- value	5.22		6.08	
	p- value	<0.001*		<0.001*	
	Significance	Significant		Significant	
AGILITY	Mean	19.3	22.57	19.27	21.93
	SD	3.399	3.579	5.105	5.115
	t- value	4.841		4.929	
	p- value	<0.05*		<0.05*	
	Significance	Significant		Significant	

LOS= 0.05, df =29, 't' tab= 2.05
*p ≤ 0.05- significant
Paired 't' test gave 't' values that were statistically significant for coordination, reaction time and agility.

TABLE 2: Unpaired 't' test results for intergroup comparison between group A and B

INTERGROUP COMPARISON **Group A**		**PRE SCORES**		**POST SCORES**	
		Group B	**Group A**	**Group B**	
HAND EYE COORDINATION	Mean	15.40	17.73	18.30	21.13
	SD	5.37	6.50	5.19	6.88
	t- value	1.515		1.80	
	p- value	>0.05		>0.05	
	Significance	Non-significant		Non-significant	
REACTION TIME	Mean	13.75	13.36	10.01	10.00
	SD	3.151	2.965	2.88	2.30
	t- value	0.502		0.024	
	p- value	>0.05		>0.05	
	Significance	Non-significant		Non-significant	
AGILITY	Mean	19.03	19.27	22.57	21.93
	SD	3.9	5.10	3.579	5.112
	t- value	0.208		0.556	
	p- value	>0.05		>0.05	
	Significance	Non-significant		Non-significant	

LOS= 0.05, df =28, 't' tab= 2.00
*p less that 0.05- significant
Unpaired 't' test gave 't' values that were statistically non-significant for coordination, reaction time and agility both before and after the intervention.

DISCUSSION

The current study aimed to see the effect of virtual table tennis on coordination, reaction time, and balance of collegiate students and compare it with the effect of real table tennis. The subjects in this study had similar baseline values for age, height, weight and BMI. Data was meaningfully assorted through paired t test within the groups. Group A were who played table tennis in real world and group B were who played table tennis virtually. The results of the current study showed that the t values of hand eye coordination, reaction time and agility assessed using hand eye coordination test, plate tapping test and Davies test respectively, were statistically significant with $p<0.05$ in both group A and group B. Similar results were seen by Oagaz et al who conducted a study to see whether table tennis training through VR helps in performance improvement and skill transfer and concluded that complex skills can be learned in VR and that obtained skills can be transfered to the real world.[13]

After this, the scores of both group A and group B were compared using unpaired t test, the results showed that the t values were not statistically significant with $p>0.05$ for hand eye coordination, reaction time and dynamic balance. Though, the results showed significant improvement in scores after playing table tennis for 4 week in both virtual and real environment,but there is no significant difference in the effect of table tennis when played on real table tennis table or through virtual reality ping pong pro game on PSVR.

That is in line with a previous study conducted by Petri K et al. who compare the response quality and attack recognition in karate kumite between reality and virtual reality, and concluded that application of VR for training is appropriate and as effective as reality. Loba to DF also in his study compared the effects of plyometric and virtual training on physical and functional performance and concluded that both trainings are equally effective and appropriate.[15]

In line to the above results and discussion, this study concluded that virtual reality sports gaming is useful in improving coordination, reaction time and agility is equally effective as sports played in real environment.

CONCLUSION

The study concluded that there were no significant differences in effect of real and virtual environment gaming on reaction time, coordination and agility, therefore null hypothesis was accepted and alternate hypothesis was rejected at a 0.05 level of significance. The study found that people who played table tennis both in a real environment and through PSVR had a major improvement in reaction time, significant gains in coordination and a considerable increase in agility. The findings revealed that virtual reality table tennis is an equally effective, if not superior medium, for improving reaction time, coordination and agility among amateur collegiate students than real table tennis. The study found that virtual reality gaming can be utilized as a supplement or substitute to increase reaction time, coordination and agility in recreational players depending on the need.

Source of funding: No funding was obtained for the study

Conflict of Interest: No conflict of interest are present.

Ethical clearance: The research was conducted after ethical approval from Baba Farid Unniversity of Health Sciences. Written informed consent were provided by all participants prior to participation.

Study period: The study took 10 months for completion from June 2022 to April 2023.

Disclosure of relationships and activities:

Minal Goyal (author)- Reseach student of MPT(sports). The study was conducted by the author as dissertation work for MPT degree.

Manharleen Kaur(corresponding author)- Supervisor. The corresponding author was the guide under whose supervision the study was conducted. The research was thoroughly checked and assisted for proper procedure and ethical conduct at every step by the supervisor.

Loveleen (co-author)- Co-Supervisor. Co-guide for the research, assisted in permissions from different places for data

collection, proper procedure to conduct pre and post tests was taught and supervised, helped in compilation and analysis.

Navneet Kaur(co-author)- Fellow student, helped in collection and compilation of data. Helped in teaching the controls and rules of the game and supervised the participants during intervention.

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