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Efecto de un programa de entrenamiento de Playstation VR de inmersión total en el desarrollo de las habilidades perceptivas de los niños en el voleibol

The effect of a full immersive Playstation VR training program on the children's perceptual abilities development in Volleyball

O efeito de um programa de treinamento de totalmente imersivo do Playstation VR no desenvolvimento das habilidades perceptivas das crianças no Voleibol

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RESUMEN

Este estudio examinó el efecto de dos intervenciones educativas, un programa basado en juegos de realidad virtual totalmente inmersivos (FIVE) y un programa de entrenamiento típico (TT), en Percepción de profundidad (DP) y Tiempo de reacción de anticipación (ART) de cuarenta y ocho jugadoras de voleibol de 8 a 10 años. El grupo FIVE asistió a un programa inmersivo completo en Playstation4VR y el grupo TT a un entrenamiento típico en la cancha, basado en mejorar DP y ART durante 6 semanas, dos veces por semana durante 24 min cada vez. El grupo de control no recibió ningún programa estructurado de formación en PD y ART. Antes, después y un mes después de las intervenciones, se calculó la DP utilizando el Probador de Percepción de Profundidad Eléctrica y el ART utilizando el Temporizador de Anticipación de Bassin. Se realizaron análisis de varianza bidireccionales con medidas repetidas, para determinar el efecto de los grupos de programas de entrenamiento y las mediciones en los dos movimientos en el rendimiento de DP y las dos velocidades (5 mph y 10 mph) en el rendimiento de ART. Las puntuaciones de las pruebas posteriores y de retención DP en ambos movimientos fueron notablemente mayores que las de las pruebas previas para ambos grupos experimentales, pero no para el grupo de control. Además, en las puntuaciones de ART, sólo en 10 mph, las puntuaciones de las pruebas posteriores y de retención fueron notablemente mayores que las puntuaciones previas a la prueba para ambos grupos experimentales y no para el grupo de control. En conclusión, los exergames VR y un entrenamiento típico son herramientas efectivas para mejorar el DP y ART en jugadores de voleibol de 8 a 10 años de edad.

Palabras clave: Voleibol, exergame, inmersión total, realidad virtual, percepción de profundidad, tiempo de reacción de anticipación.

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ABSTRACT

This study examined the impact of two different educational interventions, a program that were based on full immersive virtual reality games (FIVE) and a typical training program (TT), in Depth Perception (DP) and Anticipation Reaction Time (ART) of forty-eight female volleyball players aged 8-10 years old. The players were randomly separated into three individual groups of 16 children each, two experimental groups (FIVE, TT) and one control group. The FIVE group attended, for 6 weeks, twice a week and 24 min per session, a full immersive program in Playstation4VR and the TT group a typical training to the court, based to improve DP and ART. The control group did not receive any structured DP and ART training program. Before the interventions, after and one –month after, DP was estimated using Electric Depth Perception Tester and ART using Bassin Anticipation Timer. Were conducted Two-Way analyses of variance with repeated measures, to demonstrate the impact of educational interventions measurements across the two movements on DP efficacy and the two speeds (5mph and 10mph) on ART performance. The post and the retention tests DP in both movements scores were remarkably greater than pre-test for FIVE and TT groups but not for the control group. Additionally, on the ART scores, it was observed that only at a speed of 10 mph did the post and retention test scores show a significant increase compared to the pre-test scores for both experimental groups, while no such increase was observed in the control group. To conclude, exergames VR and a typical training are effective tools for improving DP and ART in volleyball players aged 8-10 years old.

Keywords: Volleyball, exergame, full immersive, virtual reality, depth perception, anticipation reaction time.

RESUMO

Este estudo examinou o efeito de duas intervenções educativa, um programa baseado num jogos de realidade virtual total imersivos (RVTI) e um programa de treinamento típico (TT), em Percepção de Profundidade (PP) e Tempo de Reação de Antecipação (TRA) de quarenta e oito voleibolistas com idades entre 8 e 10 anos. Divididos de forma randomizata em três grupos individuais de 16 crianças cada, um controle e dois grupos experimentais (RVTI, TT). O grupo RVTI participou de um programa total imersivo em Playstation4VR e o grupo TT um treinamento típico para quadra, com base de melhorar PP e TRA durante 6 semanas, duas vezes por semana durante 24 min cada vez. O grupo de controle não recebeu nenhum programa estruturado de treinamento em PP e TRA. Antes, após e um mês após da intervenção, o PP foi estimado usando o Electric Depth Perception Tester e o TPA usando o Bassin Anticipation Timer. Foram conduzidas análises de variância de duas vias com medidas repetidas, a determinar os efeitos da grupos de programas de treinamento e medições entre os dois movimentos em desempenho de PP e as duas velocidades (5 mph e 10 mph) em desempenho de TRA. O pós-teste e os testes de retenção DP em ambos os escores de movimentos foram notavelmente maiores do que o pré-teste para ambos os grupos experimentais, mas não para o grupo de controle. Além disso, nas pontuações de ART, apenas em 10 mph as pontuações do pós e do teste de retenção foram notavelmente maiores do que as pontuações do pré-teste para ambos os grupos experimentais e não para o grupo de controle. Em conclusão, os exergames VR e um treinamento típico são ferramentas eficazes para melhorar a DP e ART em jogadores de voleibol de 8 a 10 anos de idade.

Palavras chave: Voleibol, exergame, imersão total, realidade virtual, percepção de profundidade, tempo de reação de antecipação

INTRODUCTION

In volleyball, with a changing environment, the development of Perceptual Abilities (PA) is considered particularly crucial. Specially, the required features for high performance in the sport of volleyball such as efficiency of reaction speed, when the ball, the athlete, teammates and adversaries are the main sources that generate information (Dina et al., 2013), enforce the obtaining of PA, which are associated with problem-solving process and information processing speed (Magill, 1998), and especial Depth Perception (DP) and Anticipation

Reaction Time (ART). In particular, DP is the ability of a person to perceive the distance of the coming objects (Williams et al., 2000) and is reported as vital to efficient performance in games that use ball (Oxendine, 1984). Belisle (1963) provided a definition of ART, stating that it involves the ability to synchronize a motor response with the arrival of an object at a specific point in both time and space. This test is commonly utilized to assess hand-eye coordination and the ability to anticipate and accurately respond to visual stimuli. Specifically in sports that require from their athletes precise catching or hitting the ball, this perceptual ability is presumed to be a major factor in the success of efficient play (Schmidt & Lee, 2005).

Elite athletes in volleyball were characterized by superiority in ART (Kioumourtzoglou et al., 1998; 2000), also, according to Gunay et al. (2019) middle volleyball players were better at the fast stimulus speed than outside players in ART. On the other hand, Brady (1996) showed that ‘open skills athletes’ (volley-ball) were more precisely and less changeable in ART than ‘closed skills athletes’ and non-athletes, at the faster speeds. From the above it can be seen that expert athlete can only gain an advantage in ART task if the kinematic characteristics of the ball are similar to those faced on the athletes’ practice field. Similarly, experienced table tennis players were better at ART than novice players, especially in timing their reactions to decelerating trajectories (Ripoll & Latiri, 1997). After all, individual differences in DP concern information which is more specific to the skill being performed (Westerman & Cribbin, 1998). Anticipatory skill, also, plays a key role particularly in volleyball where players need to watch the actions and positions of various players at the same time (Nuri et al., 2013).

The development of PA and particularly DP and ART appear to have a very important role in expert performance; the question is whether and how these features could be trained (Abernethy et al., 1999). Intensive training in sports that have fast ball movement leads to improved accuracy in the ART (Abernethy, et al., 1999; Benguigui & Ripoll, 1998). The more one practices the more develops cognitive aspects, helping the player to understand the game and lead to faster responce (Barcelos et al., 2009). Moreover, significant effect on attention could have the collective physical-sporting activity (Enríquez Molina et al., 2023; Reigal et al., 2023). Additional, video-based perceptual training can improve ART and decision accuracy (Larkin et al., 2018). However, the visual training programs that Abernethy & Wood (2001) used appear to offer no advantage in enhancing DP and ART. According to Dina et al. (2013), the training program focusing on the perceptual models can improve not only the perception but also the way they play. This training program could additional be extended to the use of perceptual models and for other game actions. In addition, the skill of hand-eye coordination s trainable and contributes to the athlete’s athletic performance (Pratama & Irianto, 2018). In addition, were found significant relationships between actual and perceived athletic performance and sport participation (Müller Zuñiga et al., 2022). All of the above, therefore, must be trained from an early age as they are a prerequisite for athletic superiority (Zetou & Haritonidis, 2002). In addition, according to Mazzoccante et al. (2022), children participating in Physical Education classes at school for two weeks accomplished greater motor domains and cognitive flexibility.

There are various TT programs to train and develop DP and ART, one possible new training method could be through physically interactive video games, such as exergames, which are “video games that require physical activity in order to play” (Oh & Yang, 2010). More specifically, exergames are video games which motivate users to exercise by exploiting different technologies (Nurkkala et al., 2014). A type of high-tech video game is one that uses Virtual Reality (VR). VR is a technology that uses computers and special devices to let you feel like you are in a different world and do things like you would in real life. Crucial for the VR is immersion, the participant’s perception of his or her own presence in the Virtual Environment (VE). The VE can become Full Immersion with a variety of visual interfaces such as desktop monitors, Head-Mounted Displays (HMD) and haptic interface devices (hand controllers and joysticks) that are able to provide to a player an experience with a variety of textures. Especially, the HMD is a device that the player wears on her/his head cover his/her eyes and make him/her blind to real world. The virtual world can be seen in stereovision from the two small screens of HMD with

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a wide field of view, besides with its head tracking, by turning their heads the players is allowed to view areas of the VE that are outside of their field of view (Alhadad & Aboo, 2018). By this way, VR could provide enhanced physical activity during dynamic gaming in contrast to typical displays (Perrin et al., 2019). This is a valuable exergame platform as can give to the players an immersive experience by feeling fully present in the VE without distraction, providing an alternative helping exercise at an intensity equivalent to real-world PA (Faric et al., 2019). Some VR gaming consoles are the following: HTC Vive (HTC and Valve), Oculus Rift and PlayStation VR (Pallavici et al., 2019; Sveistrup, 2004).

Studies to exergames exposed that, the participation in exergames can boost physical activity (Sinclair, Hingston, & Masek, 2007; Oh & Yang, 2010), with an enjoyable way (Faric et al., 2019), being more attractive to young people (Nurkkala et al., 2014), and finally reduce reaction time (Politopoulos, 2015). VE can provide a controlled scenario, and this consists of an advantage of VE (Bideau et al., 2004), helping the players to interact with situations repeatedly and safely (Altenhoff et al., 2012; Huang et al., 2017). This is the reason of why exergames have been applied with successful in an extensive field of educational situations such as sports training (Komura et al., 2002) improving the teaching of skills that are related to sports (Eaves et al., 2011). Besides that, the key role in the motivation and continued engagement of players is the immersion and presence in VR exergames play (Faric et al., 2019). Additionally, during periods of lockdown (Covid-19) where athletes had to stay away from PA, VR could be used. Particularly, was observed that during the period of home confinement, the VR use has increased very much, expressing, the players, positive view on the effect of VR activities on their mental and physical wellbeing (Siani & Marley, 2021). Moreover, VR appears to be effective in relieving pain during COVID-19 post-treatment intensity and pain-related impairments in activity, mood, and stress (García et al., 2021). Furthermore, it was found that, can decrease RT in children (Amprasi et al., 2021) and in healthy older adults, a training program with VR (Bisson et al., 2007). Likewise, after four –weeks of an education intervention with VR can develop the RT in children with cerebral palsy (Pourazar et al., 2018). Moreover, a FIVE intervention in children can reduce other two perceptual abilities, selective attention (Amprasi et al., 2022) and Whole-Body reaction time (Amprasi et al., 2021). However, Armbrüster et al. (2008) study shows that DP is insufficient in simple VE and that simple manipulation do not improve depth estimations. In general, interventions in VR can evoke actual outcomes in sports efficiency enhancement via athletes' motor and psychological skills and abilities, including perceptual movement skills, strategy, tactics and decision-making, response to emergencies, and improving psychological and mental recovery capabilities (Richlan et al., 2023).

After reviewing the literature, it was found that the interventions using VR programs that have been implemented to date: a) have not done on how to develop and improve DP and ART, b) were not targeted at volleyball female players, and c) were not conducted in players aged 8-10 years old with a control group. Consequently, the paucity of research on the using of full immersive Playstation VR training programs in DP and ART improvement, sparked the authors to design and accomplish a survey focusing on the effect of full immersive virtual reality on kids' DP and ART improvement, as compared to typical methods for the improvement of such perceptual abilities. So, this study is original and will fill this gap in the research literature. Investigating whether FIVE could be used in the training of female volleyball players aged 8-10 years old to develop their DP and ART by examining, also, the short- and long-term impacts.

The aim of the current survey was to determine the impact of two different educational interventions in DP and ART of children aged 8-10 years old. A program that was based on FIVE games and a TT program. Particularly, the survey examined the following research questions:

(1) Are there differences in initial mean DP and ART tests scores between the TT, the FIVE and the Control groups?

(2) Do children, on average, report differently on the DP and ART tests for the pre-test, post-test and one – month retention test measurements?

(3) Do the differences in means for the DP and ART tests between the TT, the FIVE and the Control groups vary between the pre-test, post-test and one – month retention test measurements?

This survey can give a helpful guidance to the international research community regarding the efficiency or no of full immersive VR games as vehicles for developing DP and ART among volleyball girl players aged 8-10 years old.

MATERIAL AND METHODS

The present study is an experimental study with a duration of four months and propose to examine the effects of two different educational interventions in DP and ART of kids aged 8-10 years old, with pre-, post- and retention analysis conducted (Ato et al., 2013).

Participants

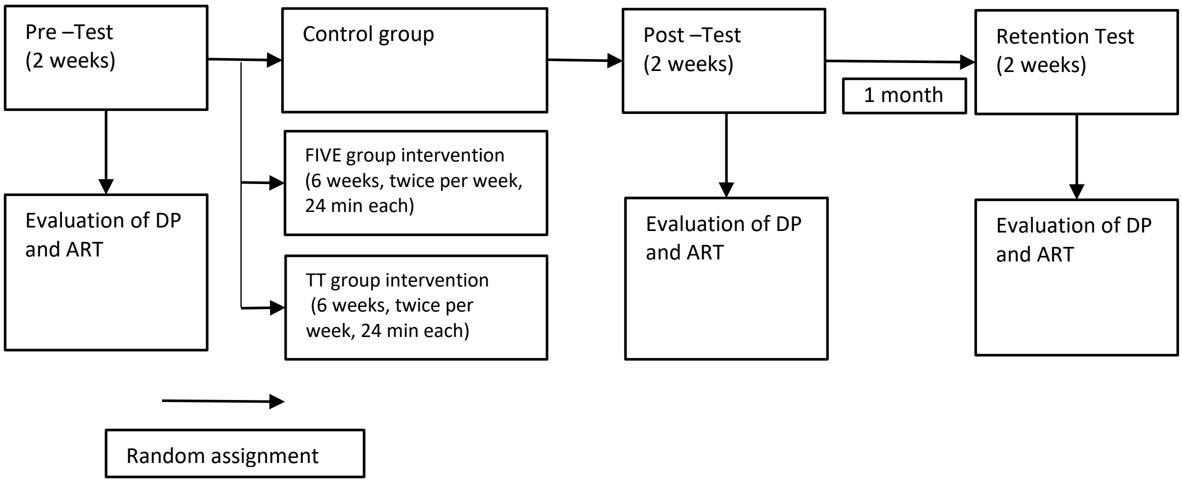
The sample of the survey consisted of forty-eight (*n* = 48) girls of ages between 8 and 10 years –old (mean 9.27 ± 0.77 years), who have been playing volleyball in a volleyball club in Komotini (in Greece). The sample has participated in volleyball activities for one year. The participants who used for the current study were self-selected and were randomly split into three groups with 16 girls in each group, one control group and two experimental groups (FIVE and TT). First, parents who had expressed interest in participating in the survey, informed regarding the study requirements, and then checked to make sure the children wanted to join in. Prior to group assignments, girls were checked against the inclusion and exclusion criteria. Specifically, children had to be 8-10 years when the survey started, to be able to use exergames and to be able to participate in the intervention program. Moreover, they couldn't participate if they had a clinically serious illness or disability that makes it impossible to accomplish the intervention program. This survey was approved in advance by the Democritus University of Thrace (protocol. 6-2020 M.A).

Procedure

Initially, conducted a pre–test where assessed DP and ART. Participants were then randomly divided into three individual groups of 16 participants each, randomly, two experimental groups (FIVE and TT) and one control group. Participants, who were in the control group in their training program, did not receive any structured program. On the other hand, participants in the two experimental groups have attended 12 practice sessions based to improve DP an ART that were conducted twice a week, 24 min per session, over a 6-week period. Especially, children of the FIVE group participated in a full immersive program (Playstation4 VR) and children of the TT group training were presented to the court. When the training program ends, a post–test was administered to assess DP and ART. Ultimately, one month following the interventions without practice, conducted a retention test. The inclusive study design is shown in Figure 1.

Figure 1

The overall study design.



Before the intervention with PlayStation4 VR, the participants of FIVE group, were trained to learn the way the PlayStation4 VR is using and to play the games that were used for the study. The VR games have been chosen from the "Carnival Games" which were able to train DP were "Funnel cake stacker" and "Fast pitch". And the VR games which have been chosen to train ART were "Shark tank" and "Shooting gallery". In each training program, the participants had to play two games that were aimed on training DP and two that were based on training ART, with last 6 min each game.

Concurrent, a traditional training to the court that was based to improve DP and ART, have attended the children of TT group. A common training had the following characteristics: warm –up exercises (4 min.), two exercises to train DP and two to train ART (24 min.) and finally stretching (4 min.). One of the two exercises that were based on training DP is the one shown in Figure 2. This exercise calls "catch the ball" and the athlete must catch the ball that coach throws, in the air. In addition, one of the two exercises that were based on training ART is the one shown in Figure 3. This exercise calls "catch and give", the athletes are in the row and must catch the ball from a player and give it in another player to put it in the basket.

Figure 2

Exercise based on training Depth Perception.

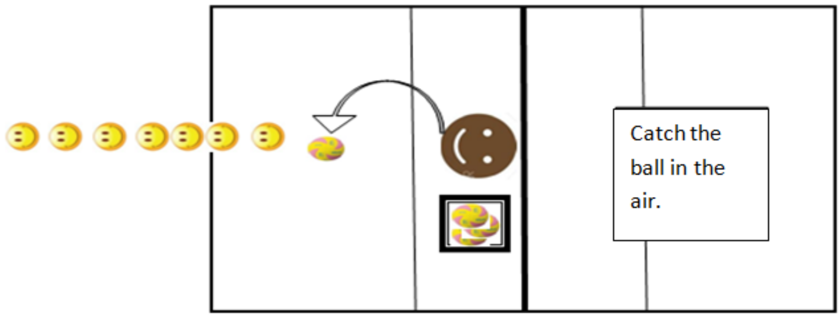
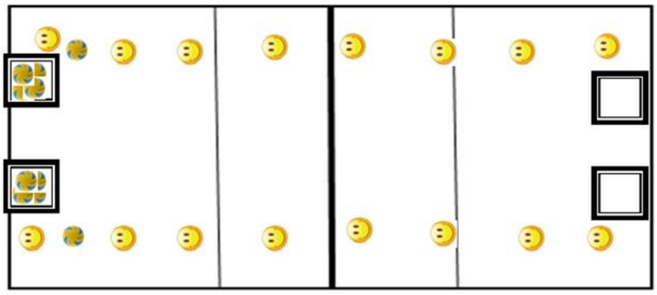


Figure 3
Exercise based on training Anticipation Reaction Time.



Measures

To evaluate children's DP, the Electric Depth Perception Tester (Takei Instruments) was used. The girls were sitting in a chair with their chin stabilized in such manner so that they were able to see a specific visual field through a slot placed 120 cm away at the level of their eyes. Through that slot, children watched a pin moving at a speed of 50 mm/s forward and backward, and they had to press a button as soon as they realized that the pin was aligned with two other pins located bilaterally 20 cm away from the moving pin. They were given two practice trials to children to confirm that they were accomplished with the motor task and were able to control their movement. When the practice ended, children had to perform four trials in forward direction and four trials in backward direction of the pin. The distance error from the point of alignment was noted for each trial in millimeters and was calculated separately a mean of those values for the forward and backward directions (Hatzitaki et al., 2002). The reliability of the test for depth perception is r = .74 (Takei Instruments).

Additionally, to evaluate ART, the Bassin Anticipation Timer (Lafayette, USA) was used. The Bassin Anticipation Timer consists of a 1.5-meter-long metal runway which contains 64 lamps through which the light passes, as well as a switch, which relates to a cable and is in the dominant hand of the examinee. The first lamp was in yellow color and was the warning –light, the next 63 red lights were movement –simulating. A controller was in connection with the runway that effected the lights to turn on or off sequentially down the length of the runway. The participants had to push the button of the controller to respond when anticipate the arrival of the light at the last light. The sequentially lit lamps light up in a raw, making it look like something is moving towards the participants. How quickly turn on and off the lights, determines the "velocity" of stimulus. The participants were seated in chair two meters from the center of the device, facing directly toward last lamp in the runway. About the impending trials were set warning light times at 1.5 sec. Each practitioner was seated in the chair and had to push a button at just a right moment when a lamp reached the end of the runway (speed of the light: 5 and 10 mph). The time from pressing the button to the arrival of lamp was automatically recorded automatically in msec. After 2 attempts at familiarization, 10 attempts followed at each speed. The variable that was evaluated was the average of the absolute values of the responses (msec) at two speeds. The reliability of the test for the anticipation ability is r = .94 (Lafayette Instruments).

Statistical analysis

The SPSS 23.0 (Statistical Package for the Social Sciences) for Windows was used to accomplish analyses of the survey's data. In table 1 there are descriptive statistics (mean and standard deviation) that were calculated for variables before the intervention, at the end of intervention and one month after the intervention. At baseline, the Levene's test was used for homogeneity. To assess the differences in the beginning in total DP and ART scores at pre –test of the participants of the three different groups, conducted One Way Analysis of Variances. Mauchly's test of Sphericity was not significant, which confirmed the appropriateness of the test. To estimate the impact of interventions and measurements across time on DP (front and back motion) and on ART (5mph and 10mph)

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performance, was conducted Two-Way Analysis of Variances with repeated measures. The dependent variables were DP and ART test scores. The Training program groups with three levels (FIVE, TT and Control) and Time with three levels (pre, post and one–month retention test) were the within-individuals' factors. Significant differences between the means across time were tested at the 0.05 alpha level. An effect size was computed for each analysis using the eta-squared statistic (η^2) to evaluate the practical significance of findings. Cohen's guidelines were used to interpret η^2 effect size: 0.01 = small, 0.06 = medium and 0.14 = large (Cohen, 1988).

RESULTS

In order to evaluate Hypothesis, I, was conducted One-Way Analysis of variance. DP and ART at the beginning indicated homogeneity of variance (p = .213 and p = .877 respectively). Actually, there were no significant initial differences between the three groups in the mean DP test scores, $F_{(2,45)} = 0.438$; p = .648 > .05 and in the mean ART test scores, $F_{(2,45)}$ = .036; p = .964 > .05.

To evaluate the Hypothesis II, was conducted Two-Way Analysis of Variances with repeated measures. This hypothesis was corroborated somewhat, as demonstrated in what follows. The outcomes of this survey revealed that, regardless of whether it was FIVE or TT group, DP in both movements improved and retained in contrast with control group. In contrast with the ART, where both experimental groups improved and retained the ART in 10mph, except for the control group. In 5 mph ART no group had significant improvement (Table 1).

Table 1
Pre, Post and Retention Tests in DP (Front and Back motion) and ART (5mph and 10mph) mean ± SD.

			Pre –test		Post –test		Retention –test	
			Mean	SD	Mean	SD	Mean	SD
	FRONT	FIVE	1.40	41	0.62	0.36	0.64	0.50
		TT	1.75	1.43	0.84	0.66	0.71	0.55
		CG	1.25	1.27	1.60	1.52	1.59	1.52
DP	BACK	FIVE	1.04	0.61	0.68	0.48	0.66	0.46
		TT	1.14	1.01	0.87	0.92	0.90	0.84
		CG	1.01	0.85	1.03	0.73	1.03	0.78
	5MPH	FIVE	0.14	0.11	0.09	0.02	0.09	0.02
		TT	0.14	0.08	0.11	0.03	0.10	0.03
		CG	0.14	0.06	0.14	0.11	0.15	0.11
ART	10MPH	FIVE	0.10	0.06	0.06	0.03	0.06	0.02
		TT	0.10	0.07	0.06	0.04	0.06	0.03
		CG	0.12	0.11	0.12	0.08	0.12	0.08

Note: SD: Standard Deviation, CG: Control Group, MPH: miles per hour.

A significant main effect was noted for front motion on DP, $F_{(2,90)} = 4.006$, $p < .05$, partial $\eta^2 = 0.144$ while the training programs × front motion on DP impact was also significant, $F_{(4,90)} = 3.082$, $p < .05$, partial $\eta^2 = 0.103$. Not significant was the univariate test associated with the Group's main effect, $F_{(2,45)} = 2.136$, $p = .130$, partial $\eta^2 = 0.087$. Pairwise comparisons using t-test with a LSD adjustment revealed significant mean differences in front motion on DP between pre–test and post–test (MD = 0.774, 95% CI: 0.36 to 1.513, $p < .05$) and between pre –test and retention test (MD= 0.755, 95% CI: 0.125 to

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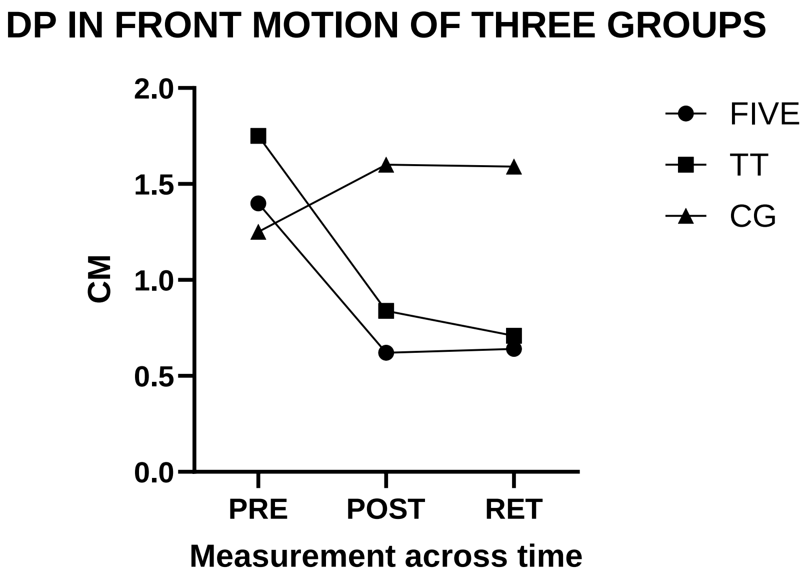
1.386, $p<0.05$) in FIVE group. In addition, were found significant mean differences in front motion on DP between pre–test and post-test (MD = 0.907, 95% CI: 0.168 to 1.645, $p<0.05$) and between pre –test and retention test (MD = 1.038, 95% CI: 0.408 to 1.669, $p < .05$) in TT group. As shown in Figure 4, the post-test in front motion on DP scores and the 1-month retention test in front motion on DP scores were remarkably lower than pre-test in front motion on DP scores for both experimental groups, but not for the control group.

Figure 4

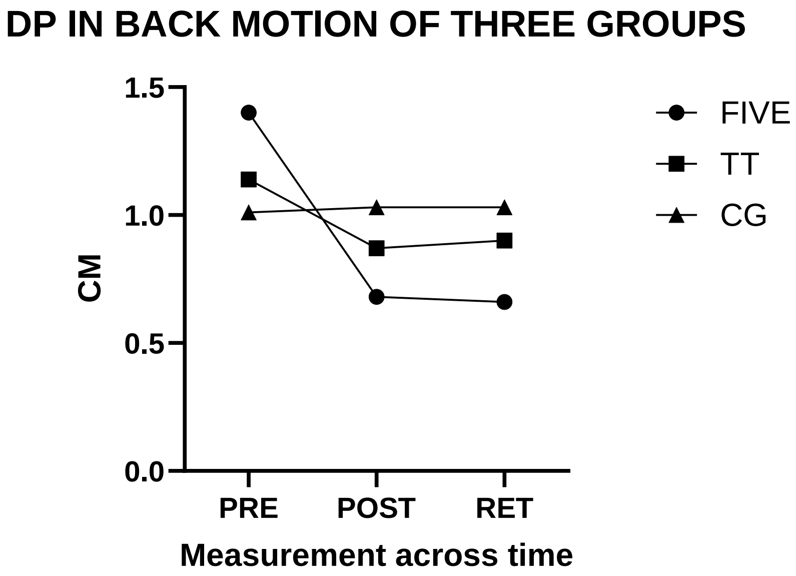
Efficiency on all measurements across time of the front motion on DP ability test of the three groups (FIVE: Full Immersive Virtual Environments, TT: Typical Training, CG: Control Group, cm: centimeters).



A significant main effect was noted for back motion on DP, $F_{(2,90)} = 17.872$, $p < 0.05$, partial $\eta^2 = 0.405$ while the training programs × back motion on DP impact was significant too, $F_{(4,90)} = 5.629$, $p < .05$, partial $\eta^2=0.152$. Not significant was the univariate test associated with the Group's main effect, $F_{(2,45)} = 0.409$, $p = .667$, partial $\eta^2 = 0.018$. Pairwise comparisons using t-test with an LSD adjustment revealed significant mean differences in back motion on DP between pre –test and post–test (MD = 0.358, 95% CI: 0.226 to 0.491, $p < .05$) and between pre –test and retention test (MD = 0.382, 95% CI: 0.223 to 0.540, $p < 0.05$) in FIVE group. In addition, were found significant mean differences in back motion on DP between pre–test and post–test (MD = 0.274, 95% CI: 0.141 to 0.406, $p < .05$ and between pre –test and retention test (MD= 0.239, 95% CI: 0.081 to 0.389, $p<0.05$ in TT group. As shown in Figure 5, the post-test in back motion on DP scores and the 1-month retention test in back motion on DP scores were remarkably lower than pre-test in back motion on DP scores for both experimental groups, but not for the control group.

Figure 5

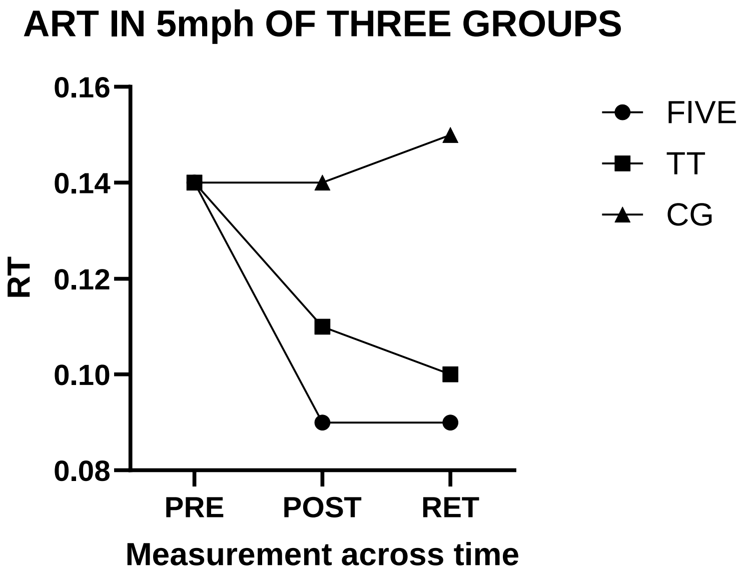
Efficiency on all measurements across time of the back motion on DP ability test of the three groups.



Not significant main effect was noted for 5mph on ART, $F_{(2,90)} = 2.367$, $p = .100$, partial $\eta^2 = 0.104$, while the training programs × 5m/h on ART impact was also not significant, $F_{(4,90)}=1.268$, $p = .289$, partial $\eta^2 = 0.057$. Not significant was and the univariate test associated with the Group's main effect, $F_{(2,45)} = 2.482$, $p = .95$, partial $\eta^2 = 0.099$. As shown in Figure 6, the post-test in 5mph on ART scores and the 1-month retention test in 5mph on ART scores were lower than pre-test in 5mph on ART scores for both experimental groups but were not statistically significant lower. Neither for the control group.

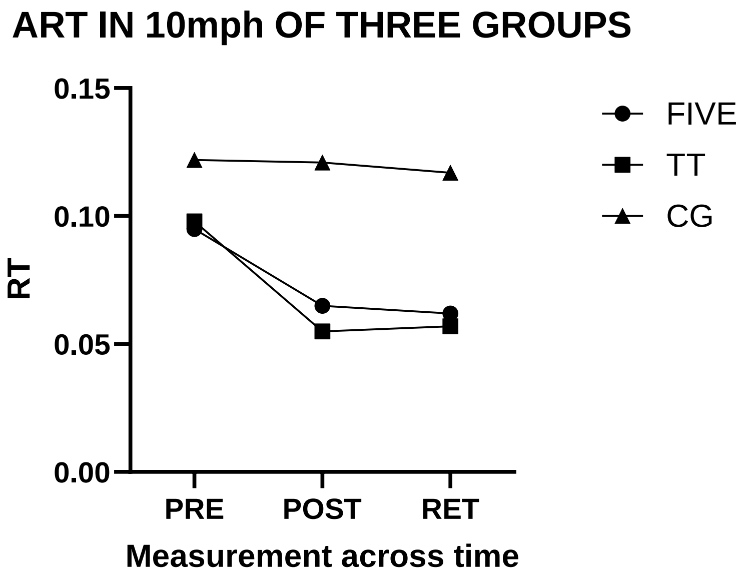
Figure 6

Efficiency on all measurements across time of the 5mph on ART ability test of the three groups.



A significant main effect was noted for 10mph on ART, $F_{(2,90)} = 8.191$, $p < .05$, partial $\eta^2 = 0.223$ while the training programs × 10m/h on ART effect was not significant, $F_{(4,90)} = 1.758$, $p = .144$, partial $\eta^2 = 0.055$. Significant was the univariate test associated with the Group's main effect, $F_{(2,45)} = 3.723$, $p < .05$, partial $\eta^2 = 0.142$. Pairwise comparisons using t-test with an LSD adjustment revealed significant mean differences in 10mph on ART between pre –test and post–test (MD= 0.031, 95% CI: 0.003 to 0.058, $p < .05$) and between pre –test and retention test (MD = 0.034, 95% CI: 0.007 to 0.061, $p < .05$) in FIVE group. In addition, were found significant mean differences in 10mph on ART between pre –test and post–test (MD = 0.043, 95% CI: 0.015 to 0.071, $p < .05$ and between pre –test and retention test (MD = 0.041, 95% CI: 0.014 to 0.068, $p < .05$ in TT group. As shown in Figure 7, the post-test in 10mph on ART scores and the 1-month retention test in 10mph on ART scores were remarkably lower than pre-test in 10mph on ART scores for both experimental groups, but not for the control group.

Figure 7
Efficiency on all measurements across time of the 10 mph on ART ability test of the three different groups.



DISCUSSION

The aim of the present study was to determine the impact of two different intervention programs, one based on FIVE and the other based on TT, on development of DP and ART. The children's DP and ART counted at the start of the interventions, after them and one month after them. The mean of millimeters was estimated separately for the front and back movements on DP. Also, the average of the absolute values of the responses (msec) at two speeds on ART was estimated.

In the end of the intervention, children in FIVE and TT group, decreased considerably the millimeters in both movements in DP and retained this decrease one month after the intervention without practice. These results confirm Barcelos et al. (2009), who showed that if children's practice is increasing, favored the improvement of the children's cognitive aspects, what helps the children to understand better the game and to construct faster responses for their actions. They are also in accordance with Westerman and Cribbin (1998), who mentioned that individual differences in DP concern information which are more specific to the skill being performed.

Children in all groups did not improve ART in 5mph, maybe because of the high flight speed of ball in volleyball (Zetou & Haritonidis, 2002). As, according to Brady (1996) and Ripoll & Latiri (1997) superiority in ART presents particularly when the

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properties of the moving stimulus are like those encountered by athletes in their field of practice. Volleyball players, moreover, are usual to high speeds and fast ball trajectories. For this reason, after all, children in both experimental groups improved their ART in 10mph. This is in accordance with Brady (1996) and Ripoll & Latiri (1997) who demonstrated that, intensive training in sports that have to do with fast ball movement leads to improvement of the ART of these athletes.

The improvement of these PA is crucial in volleyball because the environment of the game of volleyball is unstable and is characterized by a great volatility of coordinates. As a result, that generates numerous perception problems (Dina et al., 2013). The capacity, after all, to ART is a crucial procedure in the efficiency of open skills (Rothstein & Wughalter, 1987), also, helps the athletes' supremacy in sports where predicting the arrival of an object that is moving all the time, is very crucial (Molstad et al., 1994) such as the sport of volleyball. Particularly in volleyball, where there is a need of precision of catching or hitting, the important element that might contribute to successful efficiency is PA (Schmidt & Lee, 2005).

PA and particularly DP and ART, after all, seem to be very importance for expert performance; so, coaches must wonder whether could be trained these attributes **(**Abernethy et al., 1999). Exercising in VE could be an additional way as it may improve DP and ART bringing players a unique experience that is realistic. These findings are in accordance with Eaves et al. (2011) who recommended that to develop the motor skills that are relative with the sport can be used VR. In addition, VR are a very enjoyable way to practicing (Perrin et al., 2019), and developing DP and ART, two PA that are very helpful in volleyball. As these abilities are very important for volleyball because athletes have to predict the opponent's moves to make quick and correct decisions according to the movement of the players of the opposing team but also with the trajectory of the ball.

Our research suggests several methods to improve DP and ART. So, coaches can use to their trainings whichever method that is easier for them to use. Through training in the gym, using specific exercises, volleyball athletes can improve and retain these PA essential for volleyball (Oxendine, 1984; Schmidt & Lee, 2005). In combination with gym training, athletes when are playing these PlayStation VR games, can continue to practice these PA in an environment enjoyable and safe (Huang et al., 2017), as a different way of practicing DP and ART. This method could also be used in periods of home confinement (Covid-19), where athletes have to stay away from the court, however they could practice these PA at home in an enjoyable method (Faric, et al., 2019), and without fear of being injured (Huang, et al., 2017). As well, coaches, researchers and scientists are continually looking for new methods to improve sports efficiency and gain an advantage of competitive (Abernethy & Wood, 2001). Additionally, more and more people are starting to use exergames (Sinclair et al., 2007). Furthermore, exergames are workable and efficient and that's why it can be an important and powerful tool available for the Physical Education professionals (Merino Campos & Del Fernandez, 2016).

In conclusion, DP and ART are imperative in volleyball with its "open" characteristics. Specifically, are imperative due to its little predictability and because motor performance is how well anyone can predict and react to things that are happening around him/her (Fontani et al., 2006). This research can provide to physical education teachers and coaches a useful tool to develop DP ant ART with an alternative method. After all, virtual reality apps have made a big impact on how people do things in real life, like how they have fun, learn and live (Pasco, 2013). In order to keep on developing DP and ART in home the child, VR can be used alongside typical training. As, exercise and exergames both help people to be more physical active (Alhadad & Aboo, 2018). This research, thus, is in case to help physical education teachers and coaches providing to them a new tool for training DP and ART in children.

PRACTICAL APPLICATIONS

This research can be practically applied in many ways. Specifically, could help physical education teachers and coaches, providing a useful tool to improve DP and ART with an unusual way. Physical education teachers and coaches, other than traditional training that use for training these so crucial perceptual abilities for athletes, could also use VR in conjunction with traditional training to further dev elop DP and ART in home to the athletes. Moreover, this tool is also available during our stay-at-home order due to COVID-19, where all physical education teachers and coaches were in searching for ways to keep or to develop perceptual abilities. Future research should be carried out on older kids to demonstrate if full immersive VR exergames can develop other perception abilities, such as reaction time or depth perception. More studies in young athletes participating in individual sports ought to be done.

CONFLICTS OF INTEREST

All the authors reported that there was no potential conflict of interest.

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