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Effect of a Full Immersive Virtual Reality Intervention on Selective Attention in Children

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The purpose of this research was to investigate the impact of two educational interventions, a program based on Full Immersive Virtual Reality games and a Typical Training program, in Selective Attention (SA) of children aged 8-10 years old. Forty-eight girls of elementary school from the city of Komotini, in Greece, participated in this study. They were randomly divided into three individual groups of 16 children each, one Control Group (CG) and two experimental groups. The CG did not receive any structured SA training program, while the two experimental groups attended a program focused on improving SA for 6 weeks, twice a week for 24 min, each time. The participants of FIVE group attended a full immersive program in Playstation4 VR and the participants of TT group attended a typical training to the gym. Before, after and one –month after the interventions SA was estimated using Super Lab, recording the number and the RT of correct answers of relevant and irrelevant questions to volleyball. Two-way analyses of variance with repeated measures were conducted to determine the effect of training program groups and measurements across number and RT of correct answers on SA performance. Analysis of the data illustrated that the post-test SA scores and the one –month retention test SA scores were remarkably greater than pre-test SA scores for both experimental groups and not for the CG. In conclusion exergames VR are effective tools for improving SA such as typical training.

Keywords: physical activities, full immersive, virtual reality, selective attention, learning

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INTRODUCTION

Participation in Physical Activities (PA) and individual or team-based sports has been shown to benefit children's physical and mental health, socialization, and to contribute to optimize learning (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Furthermore, those who have high levels of PA in teenage years are more likely to be active in maturity and lead to have more healthy lifestyles (Telama, Yang, Viikari, Välimäki, Wanne, & Raitakari, 2005; Hallal, Victora, Azevedo, & Wells, 2006). It is a fact that, in every activity there are hidden many abilities (Adam & Willberg, 1986) which constitute the "equipment" with which an individual can perform a skill (Schmidt, 1991). In particular, abilities are distinguished in cognitive, perceptual and motor. More precisely, Perception Abilities are related to problem solving processes and the speed of information processing (Magill, 1998). Selective Attention (SA) belongs to them and is crucial when someone has to attend selectively to specific important information from a variety of visual information displayed briefly. As a matter of fact, this is an important procedure as there is a limit to how much information can be processed at a given time, and SA allows us to lose the concentration of insignificant details and focus on what is more important (McLeod, 2018). First of all, SA has been found to be very important in volleyball, in which the presence of opponents makes the selection of the relevant cues from the multitude available an ongoing process (Kioumourtzoglou, Michalopoulou, Tzetzis, & Kourtessis, 2000). Furthermore, according to Giannitsopoulou, Zisi and Kioumourtzoglou (2003), women rhythmic gymnasts were better on SA than young juniors. On the contrary, in another study, also conducted to rhythmic gymnasts, perceptual abilities tested (SRT, CRT, SA) were not affected by the performance level (Zisi, Giannitsopoulou, Vassiliadou, Pollatou, & Kioumourtzoglou, 2009). On the other hand, SA scores had been associated with the supremacy of top-level athletes (McPherson, 1993). Significantly, Rockstroh, Dietrich and Pokomy (1995) noticed that, SA can be improved after training. In particular, according to Votsis (2009), SA can be improved and practiced in a variety of different ways. More specifically, according to Ma, Le Mare and Gurd (2014) four –min high – intensity interval activities that use whole-body actions can improve SA in 9-11year olds. Considering all the above, SA is considered quite important in PA and also can be improved through exercise.

It is now clear that, there is a great variety in typical training programs aiming to develop SA. Let turn the attention to action video games, which can, also, improve attention skills (Satyen & Ohtsuka, 2001; Green & Bavelier, 2003). In other words, exergames can be suggested as an alternative way of developing them. According to Oh and Yang (2010), the most common definition of exergames is "video games that require physical activity in order to play." That is to say, these types of games inspire and motivate people to exercising by taking advantage of different technologies (Feltz, Irwin, & Kerr, 2012; Nurkkala, Kalermo, & Jarvilehto, 2014). Exergames's surveys revealed that, participating in them (video games that combine exercise and virtual environments) may encourage PA (Fogel, Miltenberger, Graves, & Koehler, 2010; Laufer, Dar, & Kodesh, 2014; Feltz et al., 2012; Campelo, Donaldson, Sheehan, & Katz, 2015; Nani, Matsouka, & Antoniou, 2019), by making it more enjoyable (Laufer et al., 2014). Also, they can improve general PA for therapeutic purposes (Donath, Rossler, & Faude, 2016; Fang, Aiken, Fang, & Pan, 2019; Pirovano, Surer, Mainetti, Lanzi, & Borghese, 2016; Dias, Silva, Amorim, Lains, Roque, Serodio, Pereira, & Santos, 2019) and for motor skill acquisition (Papastergiou, 2009; Vernadakis, Gioftsidou, Antoniou, Ioannidis, & Giannousi, 2012;Vernadakis, Derri, Tsitskari, & Antoniou, 2014; Vernadakis, Papastergiou, Zetou, & Antoniou, 2015). They can also prevent and reduce obesity (Staiano, Abraham, & Calvert, 2012; Staiano, Abraham, & Calvert, 2013) and finally reduce RT (Politopoulos, 2015). Such video games, after all, are relatively inexpensive and provide active challenges in safe and fun environments (Graf, Pratt, Hester, & Short, 2009; Fogel et al., 2010; Huang, Wong, Lu, Huang, & Teng, 2017). According to Papastergiou (2009), Nurkkala, Kalermo and Jarvilehto (2014) exergames are appealing to children and could develop motivation for PA.

This modality arose from the merger of video games with gymnastic apparatus, gaining popularity from the middle of 2006 when there was a growing interest in PA associated with gaming (Nurkkala et al., 2014). Virtual Reality (VR) is an emerging technology used for physical rehabilitation of different populations (Sveistrup, 2004). In particular, VR is a computer-based technology that incorporates input and output devices and that allows participants to experience and interact with an artificial environment as if it were the real world. Virtual environments (VE) come in many forms and often these are determined by the capabilities of the platform or hardware with which one can experience the VE. A full immersive VR setup incorporates wearable equipment that allows the user to move in the physical environment (Fox, Arena, & Bailenson, 2009). Immersion constitutes the key point of VR and is the perception that the user has about his or her existence in a VE. Immersive VR continues to be evolving because the required devices are getting more user friendly and economically accessible (Freina & Ott, 2015). The degree of immersion inside a VE is available in a varying range of visual interfaces from desktop monitors to a head mounted display (HMD) and might even include haptic interface devices (hand controllers, joysticks, and pens) which will enable an individual to experience a variety of textures. The most up to date VR gaming consoles include HTC VIVE, Oculus Rift and PlayStation VR (Sveistrup, 2004). A very important feature of VR is that the individual will move with the surroundings. An HMD is a wearable device that covers the eyes and so removes vision of the outside world. In its one or more little screens, the virtual world can be viewed in stereovision with a wide field of view. The HMD is combined with head tracking to permit the user to look at areas of the VE that are outside of the immediate field of view by turning their head (Alhadad & Aboo, 2018). VR using HMD may give increased physical load throughout active gaming compared to traditional displays (Perrin, Faure, Nay, Cattozzo, Sorel, Kulpa, & Kerhervé, 2019). Also, it is an important platform for exergaming because of its ability to provide immersive and engaging experiences (Yoo, Heywood, Tang, Kummerfeld, & Kay, 2017).

As a technology reliant on the impression of total immersion, VR fundamentally asks users to move through their environment as though they are physically present within the immersive world, and as such, could be asked to do any PA in accordance with the game's mechanics. Besides, the strongest asset in the virtual sport industry (Choi, Greenwell, & Lee, 2018), is that virtual reality is more real than reality (Lee, Chung, &

Lee, 2013). Immersive VR offers great benefits for learning, first of all, it permits a direct feeling of objects and events that are physically out of our reach, what is more, it supports training in a very safe environment avoiding potential real dangers and because of the game approach and finally it increases the learner’s involvement and motivation while widening the range of learning styles supported (Freina & Ott, 2015; Pasco, 2013). For instance, according to Muslem and Abbas (2017), the use of immersive multimedia learning with peer support has contributed an alternative and effective way, in order to improve students’ performance in English oral production skills for reading and speaking through. In addition, a virtual laboratory application, the ViPhyLab application, which is a set of physics learning media could be used from teachers to improve students’ learning independence and conceptual understanding (Arista, & Kuswanto 2018). Moreover, VR program appears effective for reducing pain intensity and pain-related interference in activity, mood, and stress posttreatment during Covid -19 (Garcia, Birckhead, Krishnamurthy, Sackman,, Mackey, Louis, Salmasi, Maddox, & Darnall, 2021). What is more, according to Siani and Marley (2021), VR use has significantly increased during the lockdown period for most participants, who expressed overwhelmingly positive opinions on the impact of VR activities on their mental and physical wellbeing. Furthermore, VR can be used to improve the teaching of sports-related motor skills (Patel, Bailenson, Hack-Jung, Diankov, & Bajcsy, 2006; Eaves, Breslin, Van Schalk, Robinson, & Spears, 2011). Additionally, a ten –week training program with VR can decrease RT in healthy older adults (Bisson, Contant, Sveistrup, & Lajoie, 2007). Similarly, a four –week training program with VR affects the improvement of RT in children with cerebral palsy (Pourazar, Mirakhori, Hemayattalab, & Bagherzadeh, 2018).

The afore-presented review of the literature logically follows that the few interventions with VR training programs have been made until today: a) have not done on developing and improving SA, b) have not improved or prove the long –term effects of VR educational programs on SA, c) were in the main targeted at youngsters or adolescents with clinical conditions and not at the general population of healthy children and d) were not conducted in children aged 8-10 years old with a CG. As a result, the lack of research on the use of exergames in SA development and, especially, the lack of studies on the utilization of the newer generation exergames of full immersive Playstation VR in SA development, headed the authors of this paper to design and implement a study that addressed the impact of full immersive VR exergames on children's SA, as compared to typical approaches for the development of SA. This survey is original, as is going to fill this gap in the research literature. Exploring whether or not full immersive virtual environments to be used in the education of children aged 8-10 years old improve their SA by examining the short- and long-term effects.

The purpose of this study was to determine the impact of two educational interventions in SA of children aged 8-10 years old. A program based on full immersive VR games and a typical training program. Three groups of children involved in the study: a Control Group (CG) and two experimental groups, the Full Immersive Virtual Environments (FIVE) group and the Typical Training (TT) group. The children's SA were assessed through the Super Lab test before the interventions (pre –test), after the intervention sessions (post –test) and one month following the interventions (one –month retention test). More specifically, the following research questions examined in the study: (1) Do children, on average, report differently on the SA test for the pre-test, post-test and one –month retention test measurements? and (2) Make the differences in means for the SA (correct number and RT of relevant answers and correct number and RT of irrelevant answers) test between the TT, the FIVE and the CG vary between the pre-test, post-test and one –month retention test measurements?

The study offers the international research community helpful guidance regarding the effectiveness or ineffectiveness of full immersive VR games as vehicles for improving SA among school age children.

METHOD

Participants

Forty-eight (n=48) girls aged 8 to 10 years-old (mean 9.27 ± 0.77 years) from elementary schools from the city of Komotini in Greece, participated in this study. The sampling frame that used for this study was self-selected and participants were randomly divided into three individual groups of 16 children each. One CG and two experimental groups, the FIVE group and the TT group. Prior to group assignments, children whose parents had expressed interest in taking part in the study were screened to confirm that they were willing to participate, once being informed regarding the study requirements and being checked against the inclusion and exclusion criteria. Inclusion criteria were: aged 8-10 years at the beginning of study, able to use VR exergames, able to attend all the classes of the intervention program and have knowledge of volleyball. Exclusion criterion was a current clinically severe health problem or disorder creating it not possible to perform the intervention program. Then, parents of the children were asked for a written informed consent statement that the children could participate in the research.

Procedure

After collecting the written consent, a pre–test was conducted where SA was assessed (number and RT of correct answers of relevant and irrelevant questions). Then, a random assignment was performed to create a CG and two experimental groups for the study. The CG did not receive any structured SA training program. Participants of the two experimental groups participated in 12 practice sessions that were conducted during 6 weeks. Participants of the FIVE group have attended a SA program based on full immersive virtual environments (Playstation 4 VR). Whereas, participants in TT group have attended a typical SA training. After the intervention, a post –test was conducted to assess SA. Finally, a retention test conducted one month following the interventions. The overall study design is conferred in Figure 1.

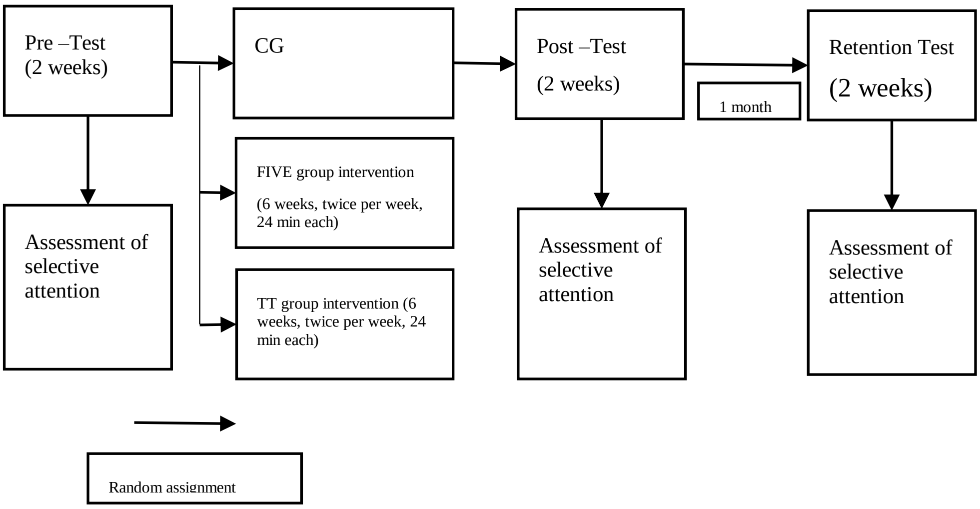

Figure 1
The overall study designs

The program lasted at total six weeks. Prior to the training program with Playstation4 VR, the FIVE group received an introductory tutorial on how to use the Playstation4 VR and how to play the games. The frequency of attendance was twice a week, while the session lasted 24 min. In particular, in every session, the participants were able to play the four games that were based on training SA, in random order in each session, with last 4 min each game and 2 min rest between the games. The VR games have chosen from the “Carnival Games” that would train SA were “Ring Toss”, “Down the stretch”, “Shooting Gallery” and “Shark Tank.” At the same time, the TT group participated in a training program to the gym aiming to develop SA. Frequency was twice a week for 24 min each training. A typical training was, initially warm –up (4 min.), four exercises based on training SA (16 min.) and stretching (4 min.). The order of four exercises was randomly changed in each training session.

Measures

To evaluate children’s SA, the Super Lab (Cedrus Corporation, 1991) was used. The test was specially adapted to volleyball. A set of 20 photographs were viewed successively on a monitor. The content of the pictures was volleyball plays. The photograph appeared for only 0.7 sec. to the practitioner. After the play of the picture, appeared on the monitor two questions, one about content relevant to the sport (about the ball or the player) such as "The player is going to do a service?" and one irrelevant to the sport, e.g., “What was the color of the roof?”. Children had to respond whether they had seen this information as possible by pressing one of the two answer keys (key A for Yes or key L for No) on the keyboard of the PC. There were three practice trials.

The number and the reaction time (RT) of correct responses relevant and irrelevant to volleyball were the variables that recorded. The reliability of the test is α=.97.

Statistical Analysis

The SPSS 23.0 (Statistical Package for the Social Sciences) for Windows was used to perform analyses of the study's data. One way analysis of variances (One-Way ANOVA) conducted to evaluate the initial differences in SA of the participants of the three groups at pre –test. Four two-way analysis of variances (ANOVA) with repeated measures were conducted to evaluate the impact of training programs and measurements across RT and number of correct responses on SA performance. The dependent variable was SA test scores. The within-individuals' factors were Training program groups with three levels (FIVE, TT and CG) and Time with three levels (pre –test, post –test and retention test). Significant differences between the means across time were tested at the 0.05 alpha level. An effect size was computed for every analysis using the eta-squared statistic (η^2) to assess 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). The hypotheses of this study were:

(H1) The three groups of children (FIVE, TT and CG) will not differ significantly on measure of SA (number and RT of all CA) at pre-test.

(H2) The children in both experimental groups (FIVE and TT) would improve and retain their performance on SA, in contrast with those in the CG group.

(H3) The children in both experimental groups (FIVE and TT) will not differ significantly on measure of SA (number and RT of all CA).

FINDINGS

One-way analysis of variance (ANOVA) was conducted to evaluate Hypothesis I (that the three groups of participants would not differ significantly on measure of SA at pre-test). Indeed, there were no significant initial differences between the three groups in the mean SA of the number of all CA $F_{(2,45)}= 2.020$; $p= 0.144>0.05$ and of the RT of all correct answers: $F_{(2,45)}=0.482$; $p= 0.620>0.05$.

Two-way analysis of variances (ANOVA) with repeated measures was conducted to evaluate the Hypothesis II (those participants in both the FIVE and the TT groups would improve and retain their SA, in contrast with those in the CG). As demonstrated in what follows, this hypothesis was corroborated. The outcomes of the present study revealed that, regardless of whether it was FIVE or TT group, SA improved and retained in contrast with CG (Table1).

Table 1
Pre, post and retention tests in all parameters of all groups (mean ± SD)

	FIVE group			TT group			CG		
	Mean score (SD)Pre	Mean score (SD)Post	Mean score (SD)Ret	Mean score (SD)Pre	Mean score (SD) Post	Mean score (SD)Ret	Mean score (SD) Pre	Mean score (SD) Post	Mean score (SD)Ret
CA Rel.	12.63 (3.07)	14.13 (2.28)	15.19 (2.26)	11.13 (4.41)	12.87 (5.27)	13.81 (4.29)	10.38 (3.46)	12.75 (2.46)	11.31 (3.52)
RT CA Rel. (msec)	3415.25 (448.02)	3204.62 (549.68)	2836.96 (551.04)	3603.81 (555.39)	3151.44 (649.20)	2901.43 (767.50)	3584.44 (336.78)	3480.83 (329.40)	3643.44 (437.81)
CA Irr.	11.12 (3.58)	11.25 (3.49)	13.06 (2.52)	8.44 (3.61)	10.00 (4.26)	11.50 (4.03)	9.37 (3.91)	9.18 (2.61)	8.69 (3.14)
RT CA Irr. (msec)	3408.06 (405.24)	2998.83 (516.47)	2658.05 (504.59)	3411 (555.15)	2843.75 (624.01)	2713.75 (788.76)	3463.19 (276.53)	3417.79 (392.85)	3481.13 (366.15)

Note. SD: Standard Deviation, CA: Correct Answers.

A significant main effect was noted for number of CA Rel. to volleyball $F_{(2,90)}$= 12.121, p<0.05, partial η^2= 0.37 while the training programs × number of CA Rel. interaction effect was not significant, $F_{(4,90)}$= 1.626, p= 175, partial η^2= 0.07. The univariate test associated with the Group's main effect was not significant as well, $F_{(2,45)}$= 2.661, p= 0.081, partial η^2= 0.11. Pairwise comparisons using t-test with a Bonferroni adjustment revealed significant mean differences in number of CA Rel. between pre –test and retention test (MD= -2.563; 95% CI: -4.356 to -0.769, p<0.05) in FIVE group. Similarly, significant mean differences in number of CA Rel. were found between pre-test and retention test (MD= -2.688; 95% CI: -4.481 to -0.894, p<0.05) in TT group. In conclusion, the retention test number of CA Rel. was remarkably higher than pre-test number of CA Rel. scores for both experimental groups, but not for the CG.

A significant main effect was noted for RT of CA Rel. to volleyball $F_{(2,90)}$= 20.175, p<0.05, partial η^2= 0.49 while the training programs × RT of CA Rel. interaction effect was significant, $F_{(4,90)}$= 7.313, p<0.05, partial η^2= 0.23. The univariate test associated with the Group's main effect was significant as well, $F_{(2,45)}$= 3.628, p<0.05, partial η^2= 0.11. Analyzing the interaction on the RT of CA Rel. for each level of the independent variable, a significant effect of the repeated factor Time was found only for the FIVE group, $F_{(2,44)}$= 15.792, p<0.05, partial η^2= 0.42 and the TT group, $F_{(2,44)}$= 20.5, p<0.05, partial η^2=0.48, but not for the CG, $F_{(2,44)}$= 1.221, p= 0.305, partial η^2=0.05. Pairwise comparisons using t-test with a Bonferroni adjustment revealed significant mean differences in RT of CA Rel. between pre –test and retention test (MD= 578.292; 95% CI: 307.991 to 848.593, p<0.05) and between post –test and retention test (MD= 367.659; 95% CI: 111.621 to 623.697, p<0.05) in FIVE group. Similarly, significant mean differences in RT of CA Rel. were found between pre-test and post –test (MD=

452.375; 95% CI: 144.024 to 760.725, p<0.05) and between pre –test and retention test (MD=702.386; 95% CI: 432.085 to 972.687, p<0.05) in TT group. In conclution, the retention test RT of correct answers relevant was remarkably higher than pre-test RT of CA Rel. scores for both experimental groups, but not for the CG.

A significant main effect was noted for number of CA Irr. to volleyball $F_{(2,90)}$= 3.325, p<0.05, partial η^2= 0.16 while the training programs × number of CA Irr. interaction effect was not significant, $F_{(4,90)}$= 2.133, p= 0.083, partial η^2= 0.10. The univariate test associated with the Group's main effect was significant as well, $F_{(2,45)}$= 4.313, p<0.05, partial η^2= 0.16. Analyzing the interaction on the number of CA Irr. for each level of the independent variable, a significant effect of the repeated factor Time was found only for the TT group, $F_{(2,44)}$= 5.940, p<0.05, partial η^2= 0.21 but not for the FIVE group, $F_{(2,44)}$= 3.046, p= 0.058, partial η^2= 0.12, and the CG, $F_{(2,44)}$= 0.331, p= 0.720, partial η^2= 0.02. Pairwise comparisons using t-test with a Bonferroni adjustment revealed significant mean differences in number of CA Irr. only between pre –test and retention test (MD= -3.063; 95% CI: -5.262 to -0.863, p<0.05) in TT group. In conclution, the retention test number of CA Irr. was remarkably higher than pre-test number of CA Irr. scores for TT group, but not for the FIVE and CG.

A significant main effect was noted for RT of CA Irr. to volleyball $F_{(2,90)}$= 33.471, p<0.05, partial η^2= 0.61 while the training programs × RT of CA Irr. interaction effect was significant, $F_{(4,90)}$= 9.151, p<0.05, partial η^2= 0.24. The univariate test associated with the Group's main effect was significant as well, $F_{(2,45)}$= 5.233, p<0.05, partial η^2= 0.19. Analyzing the interaction on the RT of CA Irr. for each level of the independent variable, a significant effect of the repeated factor Time was found for the FIVE group, $F_{(2,44)}$= 25.578, p<0.05, partial η^2= 0.54 and the TT group, $F_{(2,44)}$= 26.917, p<0.05, partial η^2= 0.55, but not for the CG, $F_{(2,44)}$= 0.188, p= 0.829, partial η^2= 0.008. Pairwise comparisons using t-test with a Bonferroni adjustment revealed significant mean differences in RT of CA Irr. between pre –test and post –test (MD= 409.299; 95% CI: 168.272 to 650.186, p<0.05), between pre –test and retention test (MD= 750.016; 95% CI: 487.595 to 1012.436, p<0.05) and between post –test and retention test (MD= 340.787; 95% CI: 69.806 to 611.768, p<0.05) in FIVE group. Similarly, significant mean differences in RT of CA Irr. were found between pre-test and post –test (MD= 567.248; 95% CI: 326.291 to 808.205, p<0.05) and between pre –test and retention test (MD= 697.251; 95% CI: 434.831 to 959.671, p<0.05) in TT group. In conclusion, the retention test RT of CA Irr. was remarkably higher than pre-test RT of CA Irr. scores for both experimental groups, but not for the CG.

Two-way analysis of variances (ANOVA) with repeated measures was conducted to evaluate the Hypothesis III (those participants in both the FIVE and the TT groups would improve and retain their SA). As demonstrated in what follows, this hypothesis was corroborated. The results of the present study revealed that, both experimental groups (FIVE and TT), improved and retained SA.

A significant main effect was noted for number of all CA $F_{(2,60)}$= 19.392, p<0.05, partial η^2= 0.55 while the training programs × number of all CA interaction effect was not significant, $F_{(4,60)}$= 0.532, p= 0.590, partial η^2= 0.03. The univariate test associated with the Group's main effect was not significant as well, $F_{(1,30)}$= 2.209, p= 0.148, partial η^2= 0.07. Analyzing the interaction on the number of all CA for each level of the independent variable, a significant effect of the repeated factor Time was found for both experimental groups, the FIVE group, $F_{(2,29)}$= 7.782, p<0.05, partial η^2= 0.35 and the TT group, $F_{(2,29)}$= 10.538, p<0.05, partial η^2= 0.42 (Table 2). In conclusion, both experimental groups improved the same the number of all CA.

A significant main effect was noted for RT of all CA $F_{(2,60)}$= 49.521, p<0.05, partial η^2= 0.69 while the training programs × RT of all CA interaction effect was not significant, $F_{(4,60)}$= 0.918, p= 0.405, partial η^2= 0.94. The univariate test associated with the Group's main effect was not significant as well, $F_{(1,30)}$=0.032, p=0.860, partial η^2=0.00. Analyzing the interaction on the RT of all CA for each level of the independent variable, a significant effect of the repeated factor Time was found for both experimental groups, the FIVE group, $F_{(2,29)}$= 14.986, p<0.05, partial η^2= 0.51 and the TT group, $F_{(2,29)}$= 18.818, p<0.05, partial η^2= 0.57 (Table 2). In conclusion, both experimental groups improved the same the RT of all CA.

Table 2
Pairwise comparisons using t-test with Bonferroni adjustment

		test	MD	P	95% CI	
Number of all CA	FIVE	Pre –Retention	-4.625	.002	-7.762	-1.488
		Post –Retention	-3.000	.022	-5.644	-.356
	TT	Pre –Post	-3.313	.037	-6.468	-.157
		Pre –Retention	-5.750	.000	-8.887	-2.613
RT of all CA	FIVE	Pre –Post	300.767	.005	77.761	523.772
		Pre –Retention	641.628	.000	345.743	937.512
		Post –Retention	340.861	.001	138.784	542.937
	TT	Pre –Post	482.127	.000	259.122	705.133
		Pre –Retention	704.841	.000	408.957	1000.725
		Post –Retention	222.714	.027	20.637	424.791

Note MD: Mean Difference, CI: Confidence Interval

As a result, both experimental groups improved the same in the number and the RT of CA to questions about the environment of the photos. In contrast with the CG that had no improvement. In general, both experimental groups improved the SA of number and RT of CA both in question relevant and irrelevant to volleyball, without one group being better to another in all three measurements. Whereas, the CG had no improvement as the hypotheses mentioned.

DISCUSSION

The purpose of this study was to investigate the effect of two educational interventions, one based on full immersive virtual environments and other based on typical training, in improvement of SA. Before the interventions, after them and one month after the intervention sessions, the children's SA was measured. The CA to questions relevant and irrelevant to volleyball estimated as well as the RT of these answers.

Children in both experimental groups, after the intervention, increased significantly the number of the CA and reduced notable the RT of CA in questions that were relevant to volleyball. And their improvement retained and after one month without exercise. In contrast, children in CG had almost the same CA in the same RT in all measurements. So, they had no improvement in SA development, since they did not follow any professional training program. These findings are consistent with Votsis's (2009) contention, where using the Super Lab, found the same as all experimental groups improved SA only in questions that where relevant to Badminton, except the CG. In addition to, he noticed that, within the very limited time they were allowed to observe the photograph, participants were able to identify characteristic points of skill and extract more information about the movement and its effect. They also improved their ability to focus their attention on key points of skill such as shoulder turn, racket direction and forearm turn, while also improved their ability to focus their attention on the result of skill, as to the direction and depth of the wing.

Furthermore, in irrelevant questions, both experimental groups had almost the same number of CA, but they answered more quickly, they reduced significantly the RT. Except for the CG which had no difference in all three measurements. That agrees somewhat to Votsis (2009) research, where none of the groups improved the number of CA. One possible explanation might be that the specific intervention program did not help the participants to develop and improve their focus on general environmental information. Unlike the intervention program of this study, where after the intervention, children started to give more attention in every stimulus in the environment of the photograph, and they continued to do so. Besides anyone use SA to select what stimuli are important as events occur.

SA, in overall, improved in both experimental groups, confirming the researches of Rockstroh et al. (1995) who noticed that SA can be improved after training, and Tine and Butler (2012), according to whom, providing students opportunities to participate in acute bouts of aerobic exercise may be a propitious strategy for improving SA. Also, Sanders (1998), confirmed the positive effect of exercise on RT by evaluating a significant number of studies. Furthermore, the current results also are consistent with Satyen and Ohtsuka (2001) and Green and Bavelier (2003) studies that found an increase in attention skills after video game practice although in this research researchers used full immersive virtual environments but the literature review revealed that there were not respectively surveys.

Exercising in VR after all, may improve SA bringing people a unique experience that is realistic, but without great deal of trouble (Feltz et al., 2012). VR exergames can offer a safe and repeatable learning environment, which is optimal for skills that are difficult to replicate in real-world settings (Tirp, Steingrover, Wattie, Baker, & Schorer, 2015). In addition, according to Gomez (2014) virtual learning environments support and expand initial or continued education. Moreover, VR program is a tool that could be used during periods of home confinement, as we lived due to COVID-19, where people have to stay away from PA. Specifically, the VR use was observed that has significantly increased during the lockdown period for most participants, who expressed overwhelmingly positive opinions on the impact of VR activities on their mental and physical wellbeing (Siani & Marley, 2021). On the top of all that, VR seems effective for reducing pain intensity and pain-related interference in activity, mood, and stress posttreatment during Covid -19 (Garcia et al., Darnall, 2021). Also, they have the potential to be a fun way to get exercise (Perrin et al., 2019) and improve SA that is so useful in everyday living, as it is crucial for someone to attend selectively to specific important information from a variety of visual information displayed briefly.

VR exergames are often perceived as fun to play, but the idea behind them also improves SA, which is so important to everyday living. This research proposes the combination of exercise and exergames in improving SA. Exercise and exergames together, after all, represent a more general case of enhancing physical activity (Alhadad & Aboo, 2018). Sedentary people may find joy in moving through the gameplay (Feltz et al., 2012). Participation in individual and team-based sports and activities has been shown, however, to be of benefit to children’s physical and mental health, socialization, and to contribute to optimized learning (Lubans et al., 2010). The large, positive effects of the participation in physical education have implications for long –term physical activity participation and fitness with subsequent health benefits (Mitchell, McLennan, Latimer, Graham, Gilmore, & Rush, 2013).

CONCLUSIONS

SA is imperative to one’s daily functioning by selectively attending to certain stimuli and not others, avoiding overloading the informational processing system. That would help children in their daily participation both in games (such as volleyball or basketball) and unstructured PA. This research could provide a useful tool for physical education teachers and coaches in order to improve SA with a different way. There is no doubt, after all, that VR applications have changed the way people live, play, and learn in the physical domain. As immersive VR can offer nice benefits for learning: it allows a direct feeling of objects and events that are physically out of our reach, it supports training in a safe environment avoiding potential real dangers and due to the game approach, it increases the learner’s involvement and motivation while widening the range of learning styles supported. Also, it encourages active involvement: if the user remains passive, nothing will happen. Physical education teachers, therefore, should use this technology in order to motivate hesitant, with low self-esteem and overweight children that avoid or be indifferent to physical education, to improve or train SA through VR. After all, exergames are appealing to children and can develop motivation for physical activity. Also, VR could be used in combination with traditional training in order to keep on improving SA in home the child. Perhaps this tool could be used during periods of home confinement, as we lived due to COVID-19, where children have to stay away from PA. This research, therefore, will help physical education teachers and coaches to indicate different methods to train SA in children. Besides, participation in PA and individual or team-based sports has been shown to be of benefit to children's physical and mental health, socialization, and to contribute to optimize learning. However, more studies should be conducted (possibly in younger or older children) to determine if full immersive VR exergames can improve other perception abilities, such as RT or depth perception. Also, the same research should be conduct in young athletes of individual or team sports.

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