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Research Article

Differences between traditional Visualization and Virtual reality on motor performance in novel climbers

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Abstract

This paper analyses the effect of virtual reality visualization (VRV) on climbers, with respect to the traditional visualization methodology. The study sample was made up of 21 novel climbers: Control Group CG (N=7), Traditional Visualization Group TVG (N=7) and Virtual Reality Group VRG (N=7). In order to implement the mental imagery through virtual reality, a 360° Ricoh Theta S camera and a pair of Woxter Neo VR1 goggles were used. The data analysis was carried out with a simple ANOVA of three means. No statistically significant differences were found. The results are discussed and future lines of research are established.

Introduction

Athletes have mentally trained their motor skills for many years, since many years, athletes mentally rehearse their motor skills, which literature already classifies it as a "mental practice" to separate it from the physical practice. The former is called mental imagery, consists of the recovery of previous experiences in the stored information memory, that is, the simulation of sensory experiences [1]. In this sense, the most recent studies have focused on determining the effectiveness of the use of mental imagery in the field of sports and physical activity [1].

Guillot, Nadrowska, & Collet [2], and secondly, the visualization with virtual reality. According to Bideau, Kulpa, Vignais, Brault & Multon [3], virtual reality has been applied in the sports field in the context of the perception and anticipation of actions in cooperation-opposition sports and combat sports. These authors use, as an example, the application of virtual reality to work on the anticipation in rugby players over the action of the opponent's change of direction or in the task of anticipating the trajectory by handball goalkeepers based on the movement of the player who throws the ball. In the same line, Vignais, Kulpa, Brault. Presse & Bideau [4], comment on the importance of virtual reality on the work of information perception and anticipation of the adversary's movement. Alongside this, they establish that the virtual reality is able to simulate real situations at their highest level while such situation is being controlled by the experimenter, who can modify them. In addition, it also allows keeping a track on the movements of the athlete's head so that the athlete's point of view is updated automatically, which allows to improve the feeling of reality. This has led them to state that virtual reality has greater benefits than the visualization with video.Within the theme of the present study, there are two types of visualization: the mental imagery, as

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a static state where the action is mentally simulated in a multisensory way [5], that is, the individual visualizes images that may include visual, auditory, tactile or kinesthetic components.

On the other hand, in the sports field, practitioners are continuously learning new motor actions, which is called "motor learning", defined as the ability to learn to execute new responses to motor problems. This type of learning is different from the rest in a greater modification of neural circuits the more unknown the skill learned [6]. The learning the execution of new skills is achieved mainly by practice. However, it has been found that the practice with mental visualization and the observation of videos or demonstrations significantly improve this process [2,7]. Visualization allows the mental anticipation of what can happen based on past experiences, which is a key factor of success in climbing [8]. Sport climbing is a modality that derives from mountaineering, where the goal is to ascend with the help of hands and feet to reach the "top", whether on natural rock or indoor walls. In competition, climbers have a short period to visualize the route they are to complete, which allows the analysis of the difficulty of the route, the size of the catches or the most complex steps, as well as the use of that information in the competition process [9]. In this same line, according to Pezzulo, Barca, Lamberti & Borgui [10], the previous visualization to the climbing involves the recovery of previously experienced stimuli, in such a way that the mental imagery of such stimuli causes the activation of cortical areas and specific motor programs similar to the ones activated when in contact with such stimuli (i.e. the climbing action).

The first study of visual perception in climbing was carried out by Smyth and Waller [11], who studied the interference patterns in the mental practice of different climbing routes. The authors claim that imagining different pathways requires different combinations of spatial, visual and kinesthetic processing. The vertical ascent routes show a greater visual-spatial orientation (strategy) than the horizontal crossings, which are more kinesthetic (motor execution).

In this same area, Boschker, Bakker & Michaels [12], analyze improvements of a group of inexperienced climbers who have watched a video of a climber making a route and later completed the same route. It was noted that climbers use this information successfully, and improved their performance. In this way, the observation of motor patterns through the use of videos is highlighted, as it provides inexperienced climbers with information that they can imitate to improve their performance.

The present study has focused only on a sample made up of novel climbers. Sánchez, Lambert, Jones & Llewellyn [9], state that there are no differences between groups of different levels, although the group that previously visualized had a more continual performance (i.e. making fewer breaks during the execution).

The present study is based on the non-existent literature on the application of virtual reality (VR) in climbing, as well as on the intention to carry out a first research process on this subject which would open future research lines.

The aim of this study is to compare the effect of traditional mental imagery and virtual reality visualization on motor performance in novel climbers. Two hypotheses are established: a) The Virtual Reality Group (VRG) would obtain a better motor performance compared to the Traditional Mental Imagery Group (TMIG) and the Control Group (CG); b) The TMIG would obtain a better motor performance compared to the CG.

Methods

Participants

The climbers in this study have been selected by a non-probabilistic sampling selection method, based on a process of selection according to two aspects: i. being familiar with climbing in a rockodrome; ii. Having a climbing level between 5a and 6a-6b, following French LevelGrading. The participants was made up of 21 novel climbers (N=21) who split up in three 7-fold groups: Control Group (CG), Traditional Mental Imagery Group (TMIG), and Virtual Reality Group (VRG).

Instruments

The mental imagery recording through virtual reality was made with a 360º Ricoh Theta S camera (130 x 44 x 22,9 cm. with two sensors ½ 3" CMOS. Lenses-180º aperture f/2.0; max ISO-1600). An expert climber completed the route with the camera adjusted to his head, recording all the route, to later use it with the virtual reality glasses. For viewing in virtual reality, we used the Woxter Neo VR1 (210g.) and the mobile phone model Lee Eco Pro 3 720x to record the participants´ execution. An ad hoc behavioral observation code was designed for the analysis of climbing quality. Finally, it was used the Weschler Adult Intelligence Scale (WAIS) to assess the participants' perceptive reasoning and establish equivalent sample groups by their scores.

Procedure

First of all, the subjects for the study filled out a questionnaire through which they allowed the confidential use of their private data. Before getting initiated in the study, they were explained the aim of it and the tasks to fulfill. Secondly, subjects who did not meet the above listed climbing requirements were discarded, which led to the final selection of the 21 climbers sample. Later, the group were divided into groups through the WAIS perceptive reasoning test (WAIS-IV, 2012). It consists of building a series of figures by means of red and white cubes. The subject has to reproduce a sample figure from an image within a given time. The aim of this test is the control of the perceptive reasoning as an influencing variable on the various visualization types and, consequently, on the climber's motor performance. Thirdly, once the groups had been made, the indoor rockodrome climbing test was carried out. The route was the same for all the subjects, irrespective of the imagery involved in each case the climbing catches were marked with coloured tape-red for the hands and blue for the feet. Before the test, GVR and GVT had three minutes to complete the visualization -GVR by using Virtual Reality Goggles, and GVT using no implements

Measures

A number of dependent variables were set, aimed at the definition of the motor performance, namely: task execution time (in seconds); total number of falls during execution; number of hand movements-taking each of them as the action of releasing one catch to grab other; number of proper rests-recommended points for the climbers' resting; number of inadequate rests-points not recommended for resting; number of correction movements -defined as the one made back to the previous catch; and route fulfilment -taken as the moment when the climber grabs the last catch with both hands.

The study satisfied the criteria for being exempt from the requirement of signed informed consent, as determined by the University Institutional Board from Ethical Committee.

Statistical analysis

So as to complete the statistical analysis, SPSS 23.0 Statistical Package for the Social Sciences was used. The data analysis was carried out with a simple ANOVA of three means, being $p<0.05$ for each of the dependent variables: execution time, number of falls, hand movements, proper rests, inadequate rests, correction movements and finally route fulfilment. Such variables were compared among the three groups -CG, TMIG and VRG through Tukey's Post Hoc Test. The analysis of some variables, such as "age", were discarded, for not showing any relevance in climbing. Unlike "age" the climbing grade reflects the motor performance and experience, so it was taken into account at the moment of the sample selection (among all filled out questionnaires), additionally, the sex variable was included, for the sample to be representative of the population of climbers. In the study, out of the 21 subjects 7 were women (33%), which matches the data by Giner [13], stating that the percentage of women federation licenses account for 39% of the total number

Results

Next, the results after the data collection and analysis are exposed, in relation to the variables established for the climbing test (Table 1).

No significant differences were found with respect to the variable hand movements F (2.18)=0.607, p=0.556, number of inadequate rests F(2.18)=0.522, p=0.602, route fulfilment, F(2.18)=0.231, p=0.796, or task execution time F(2.18)=1.631, p=0.223 (Figure 1).

Regarding the time variable of realization although no significant differences were found, it is interesting to note that, observing the mean and deviation graph, a difference was observed in a shorter duration execution for n2=125±26.764 compared to n1=148.29±26.228 and n3=143.43±21.501 (Figure 2).

For the number of proper rests, no significant differences were found, F (2.18)=6.231, p=0.09 for p<0.05. Despite this, observing the media graph, the TMIG stood out above the other two groups, n2=1.14±0.378 compared to n1=0.71±0.488 y n3=0.29±0.488 (Figure 3).

The variables that contributed significant results were, number of falls during execution F (2.18)=3.944, p=0.038 for p<0.05, highlighting a greater number of n3 falls compared to the rest of the groups, and paying attention to the graph n2=1.14±1.676 has a lower mean in the same variable compared to n1=1.43±1.512. For the variable number of correction movements F (2.18)=7.468, p=0.04 para p<0.05, showing a greater amount of correction movements for n1 compared to n2 and n3, the who did not do any mental imagery had more correction movement compared to the ones that did any mental imagery regardless of the method (Traditional mental imagery O virtual reality) (Figure 4,5).

Table 1: Results CG (n1), TMIG (n2) y VRG (n3).

Items	CG (n1=7)	TMIG (n2=7)	VRG (n3=7)	Value of F	Value of P
Task execution time (seconds)	148.29±26.228	125±26.764	143.43±21.501	1.631	0.223
Total number of falls	1.43±1.512	1.14±1.676	3.57±2.070	3.944	0.038
Number of hand movements	26.71±3.039	25.29±2.360	26.43±2.225	0.607	0.556
Number of proper rests	0.71±0.488	1.14±0.378	0.29±0.488	6.231	0.09
Number of inadequate rests	0.71±0.756	0.43±0.535	0.71±0.488	0.522	0.602
Number of correction movements	2.86±1.345	1.57±0.535	1.14±0.378	7.468	0.04
Route fulfilment	0.86±0.378	0.71±0.488	0.71±0.488	0.231	0.796

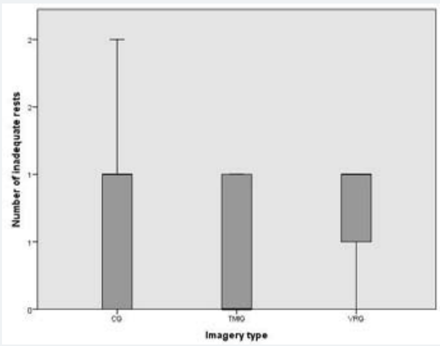

Figure 1: CG, TMIG, VRG means for the variables "incorrectly used rest".

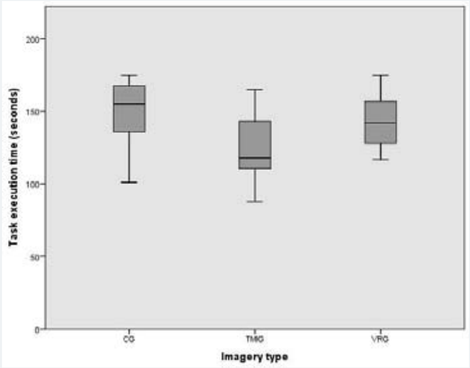

Figure 2: Means and deviations of CG, TMIG and VRG for the variable “execution time (seconds)”.

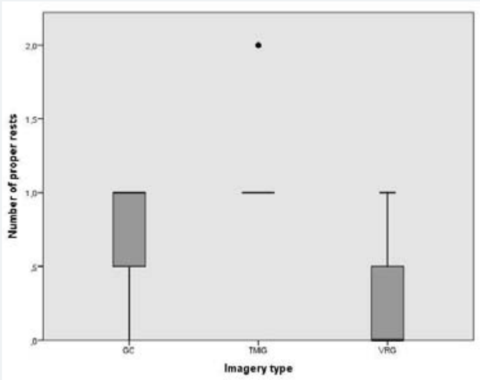

Figure 3: Means of CG, TMIG and VRG for the variable “number of proper rests”.

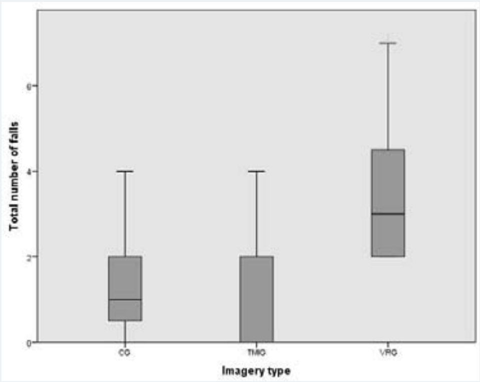

Figure 4: Means and deviations of CG, TMIG and VRG for the variable “number of falls during execution”.

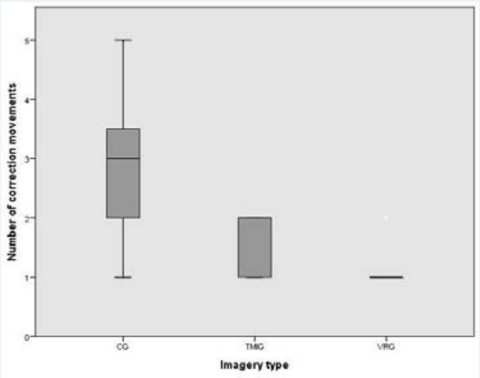

Figure 5: Means and deviations of CG, TMIG and VRG for the variable “number of correction movements”.

In addition, the correlation between some of the variables must be highlighted, for example the correction movements have a negative correlation with the number of falls, and with the route fulfilment. Also, a greater number of correction movements keeps a positive correlation with a greater number of hand movements, and directly influences the final execution time.

Based on the results obtained, the first hypothesis could not be confirmed, so the experimental group that performed VR visualization (VRG) did not show a higher motor performance, compared to the TMIG and the CG. Likewise, we can not confirm the second hypothesis, because the group with traditional visualization (TMIG) obtained a higher performance in some of the established variables, but without sufficient significance to confirm a positive influence on the motor performance.

Discussion

The aim of this study was to clarify whether visualization through virtual reality leads to significant improvement in novel climbers' motor performance through the use of traditional mental imagery as opposed to mental imagery. The results discard that visualization by virtual reality causes improvements in motor performance by novel climbers.

The results obtained in the present study are in contrast with those presented by Sanchez & Dauby [14]. These authors found benefits in the acquisition of basic climbing techniques in novel climbers through video demonstrations. The application and execution of these basic techniques were improved for the route that they had been shown in video in short periods of time, but not for a different one. Although they also found in their study that "visualization has a positive effect on the learning of basic movements of climbing in novel climbers, in comparison with the mere execution. In addition, according to these authors "it has been proven that the effect of the visualization is insignificant compared to the video demonstration" [14].

In this line Molina's work [15], found benefits among novel and intermediate level climbers in the use of GoPro, facilitating the subsequent execution in the route, as well as reinforcing the findings of Boschker et al. [16], [..."the information provided (additional) through the observation of videos made the inexperienced climbers increase their performance by compensating their inability to 'read' the route"] [15,17]. These results contrast radically with the results obtained in our study, since the use of virtual reality (VR) did not have a positive influence on the motor performance of the beginner climbers.

Due to the non-existent literature on the application of virtual reality (VR) in the area of climbing, the discussion will make use of the findings below, linked to other sports that use this technology. In a different sporting context, the performance of handball goalkeeper was analyzed by making use of video and virtual reality, which showed a more effective, accurate and anticipated performance through virtual reality. According to Vignais et al. [4], this may be due to the fact that by means of virtual reality more perceptual information is obtained compared to the two dimensions in a video. In our study, both the type of information demanded and the internal logic of the sport subject to the study may well explain the obtained results. The reason for this is that the type and number of stimuli in collective sports is completely different from the ones in climbing. In this sense, Vignais et al. [4], point out the importance of the effect of virtual reality on the perception of information and anticipation of the adversary (the latter being non-existent in escalation). This statement establishes that virtual reality is capable of simulating real situations to the maximum that add relevant information for the athlete to improve their performance in a real game situation. In this same line, Bideau et al. [3], show how virtual reality has been applied in cooperation and opposition sports, on athletes' perception and anticipation as factors for improving performance (the anticipation of changes of direction of the rival in rugby or the anticipation to the direction of the throw in handball goalkeepers).

Following these premises, the difference in the type of attentional focus conditioned by the number and type of stimuli in climbing (due to the necessary information about the catches for feet and hands, as well as the placement of them), together with the lack of anticipation to an opponent in climbing compared to other sports, can justify the lesser use of the information that virtual reality provides for this sport, and consequently the absence of positive influence on the performance compared to traditional visualization.

Along with the attentional demands of climbing, it can be added that this sport requires great technical knowledge. That is why each climber develops their own series of strategies during daily practice (depending on the type of climbing, their basic physical abilities, etc.), thus making up the motor learning process [5]. Taking this aspect into account, the useful information provided by virtual reality showing another climber can differ from the useful information that the multisensory (traditional) subjective visualization. Therefore, it does not improve the motor performance, due to the different ways of sorting out motor problems and movements between the different catches.

The results of the present study, however, coincide with those of Sanchez et al. [9]. Although these authors evaluated other variables -climbing level and how experience influences on visualization, they found that the use or non-use of visualization had no relevance in the accomplishment of the route, although they did on the performance during the realization. In the case of our study, traditional visualization did have a slight positive influence -although not significant enough-on motor performance.

Another aspect to take into account in the study is the approach to the route-horizontal crossing with a vertical end in our case- as found by Smyth & Waller [11], noting significant differences in favor of the vertical climbing -shorter performing time- over the horizontal, regardless of the type of visualization (using information on the route by indicating the catches, simulating them or even the feeling when grabbing at them.

Conclusion

After the analysis of the results, it can be concluded that the application of virtual reality (VR) in the field of climbing, as a means for visualization prior to execution, did not have a positive influence on motor performance, since the results obtained in the different variables that conform the motor performance are very similar to those obtained by the control group. Contrary to the evidences reflected in other sports fields, traditional visualization-through multisensory imagination-seems to have a small positive influence on motor performance. Such differences were not significant enough-only in 1 of 7 variables was.

On the other hand, two other variables came close to significance-route fulfillment and number of proper rests. Therefore, it could be stated that traditional visualization (by multisensory mental imagery) would be the type of visualization with a greater positive influence on motor performance in climbing-though not in a significant way.

As future research lines this study could be replicated with different climber levels-novel, advanced and experts- since the level of climbing can have an influence on the ability to visualize. Along with this, a control of the training could be carried out so that variables such as finger strength, general endurance, lactic capacity in forearms, etc., mean no change to the test. Although not directly related to the subject, the researchers of this study suggest doing further research on the recovery of injured athletes by means of visualization. Finally, more up-to-date prototypes of the Ricoh Theta S recording camera could be used, together with the Woxter Neo VR1 virtual reality goggles.

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