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8-9 March, 2021

CONFERENCE PROCEEDINGS

Sharing the Passion for Learning

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TAKE A SEAT. THE INFLUENCE OF DISTANCE TO THE BLACKBOARD ON ATTENTION AND MEMORY PERFORMANCE

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Abstract

The space around us influences our cognitive performance. There are more and more guidelines on how to design the space around us to improve cognitive abilities. The context of university classrooms is often taken as the context of studies. Since classrooms of this type can be especially large, a question still arises: does distance to the blackboard influence student performance? This was the objective of the present study: to study the effect of the students' distance to the blackboard on their cognitive performance; specifically, on attention and memory. For this purpose, a field study was conducted using virtual reality. 75 university students carried out performance tests in attention (reaction time to auditory stimuli) and memory (remembering an auditory list of words) while immersed in two photorealistic virtual classrooms replicating physical ones. This was repeated in three different design situations: X m, X+0.6 m, and X+1.2 m; X being the distance to the blackboard of the second row of seats in the original design. Analyses indicate that the distance to the blackboard significantly affects attention (but not memory) performance: as the distance decreases, attention performance increases. Results may be of interest for designers involved with these spaces, for educators interested in improving the cognitive abilities of their students by modifying the dynamics of their classes, and for researchers involved in how space can affect cognitive processes.

Keywords: University classrooms, cognitive enhancement, attention, memory, virtual reality.

1 INTRODUCTION

The space around us, which includes architectural space, has an impact on our cognitive-emotional states [1]. It is known that some design variables can affect the willingness to perform tasks [2], so it is of importance in educational spaces [3]. This has led to the deployment of increasing efforts focused on the study of the effects of architectural spaces on learning [4].

Following this line, different variables have been explored; both environmental and spatial. Environmental variables (such as air quality and temperature) have been studied more. About these, it has been shown that they have a strong impact on student performance [5]. Spatial variables have traditionally been studied less. For some, information has begun to be collected on their effect on student performance. Examples are colour and shape [6]. However, little is known about the disposition of students within the classroom, despite the fact that this is a variable that is easy to implement by the teacher and the students themselves (especially in the university context, given the larger size of these classrooms compared to those at other levels of education). As the importance of these variables, there is reason to believe that distance to blackboard may be also considerable [7].

This lack of knowledge comes from the difficulty of working with spatial variables. Most of these studies are carried out in physical classrooms, either by selecting different classrooms [4] or by modifying in a controlled manner the variables under study [8]. This is a methodological approach that, although it is feasible with environmental variables (e.g., to modify the air temperature) may be slower with the spatial variables. The modification of the furniture organization is an example. Therefore, experimentation in the physical classroom has limitations that result in some knowledge gaps.

These methodological limitations of physical spaces can be avoided through the use of virtual reality. Virtual reality allows the generation of environmental simulations, realistic and interactive in real time, through computer means. These simulations generate in the user who sees them the sensation of "being there" [9], without perceiving them as synthetic spaces [10]. In addition, the response that these spaces produce in users has been validated [11], even for the specific case of university classrooms [12]. Hence, virtual reality is a tool that facilitates research on spatial variables in the classroom.

This study analyses the effect of the linear distance of the university students to the blackboard on their performance. Specifically, at the attention and memory level. To do so, virtual reality environmental simulations were generated. This allowed a strict ceteris paribus logic to be followed, according to which all the variables (environmental and spatial) remained unchanged except for the distance to the blackboard.

2 METHODOLOGY

To address the objective, a laboratory field work was carried out using virtual reality. The participants involved (section 2.1), were exposed to different design situations in virtual classrooms (section 2.2) and in each one they performed psychological tasks of attention and memory (section 2.3).

2.1 Participants

The study involved 80 participants. 5 of them were discarded due to errors in data recording, so the database included 75 (38 women, 37 men). The average age was 24.23 years ($\sigma = 2.38$). Two criteria were established for participation: (1) be a university student; and (2) be a Spanish national.

2.2 Classrooms

Two physical classrooms were taken as an example for the stimuli. Specifically, from the Polytechnic University of Valencia. On the one hand, a classroom from the School of Construction Engineering (ETSIE), with dimensions of 16.50 x 8.80 meters. On the other hand, a classroom from the Higher Technical School of Architecture (ETSA), with dimensions of 7.50 x 5.90 meters. They were chosen because they were considered representative of the typology of university classrooms. Two virtual replicas of these classrooms were developed using Unity3D (v5.6; www.unity3d.com), and implemented to be viewed through the head-mounted display "HTC Vive" (1440 x 1600 pixels per eye; 110° field of view; 90Hz refresh rate). Figure 1 shows the virtual classrooms.

Figure 1. Virtual classrooms: ETSIE (left) and ETSA (right).
The distortion of the images is due to the virtual environment shown in 2D; when displayed in head-mounted display, the participant experiences the environment naturally.

On the virtual classrooms, three different design situations were configured: X m, X+0.6 m, and X+1.2 m; being X the distance to the blackboard of the second row of seats in the original design. Each participant experienced all six configurations (three situations in two classrooms), following a complete counterbalancing design. Figure 2 shows the six configurations.

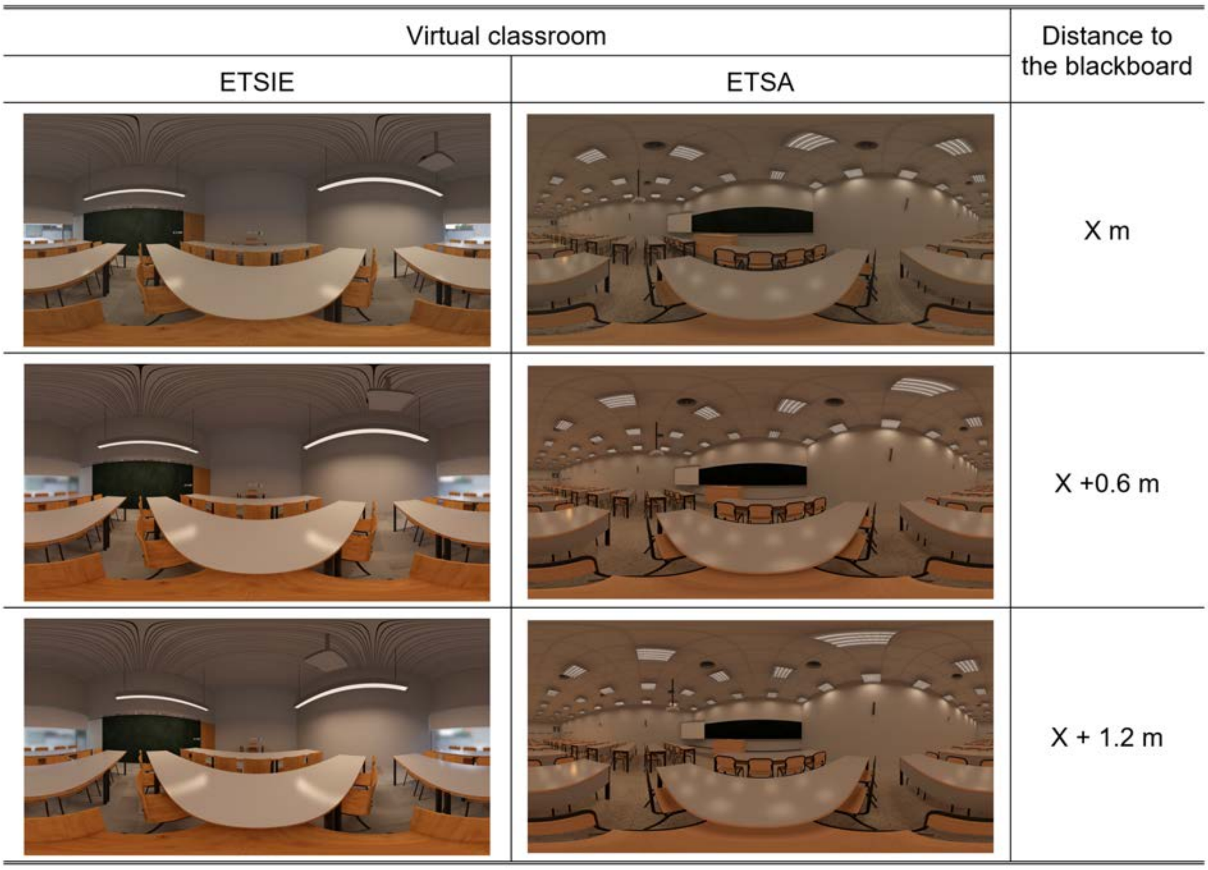

Figure 2. Configurations of the virtual classrooms, regarding the participant's distance to blackboard.

2.3 Psychological record

The participants carried out two psychological tasks: one focused on quantifying memory performance, and the other on quantifying attention performance.

2.3.1 Attention task.

During the task the participant reacted to a specific auditory stimulus (target) with a mouse click, and avoided clicking four others (distractors) stimuli (in a similar way to the auditory continuous performance test [13]. There were 8 targets and 32 distractors (20% target stimuli), the time between stimuli was 800 ms to 1600 ms, and the time to react was a time window of 750. As well as the memory task, this was done 3 times for each virtual classroom configuration. The reaction times to the target stimuli were quantified, resulting in the "Attention-Time" variable.

2.3.2 Memory task.

During this task, the participant memorised lists of words associated with a concept that was not presented as a specific word (in a similar way to the DRM paradigm experiments [14]). Each list had 15 words, with a similar recall rate [15], presented through Loquendo (v.TTS 7; www.loquendo.com). The participant was asked to listen to the words, and then repeat them in a 30-second time window. Then the list was moved to the next one. This was done 3 times for each virtual classroom configuration. The number of words remembered was quantified, resulting in the "Memory-Correct" variable.

2.4 Data processing.

The database was collected according to the above. Once anonymised, statistical analyses were carried out on this one using the software IBM SPSS (v.16.0).

3 RESULTS

The purpose was to analyse the correlation between the participant's distance to the blackboard and the variables that quantify attention (Attention-Time) and memory (Memory-Correct). Hence, the results are organized in the following sections: (3.1) distance to the blackboard and attention; and (3.2) distance to the blackboard and memory.

3.1 Distance to the blackboard and attention

Analyses measured the effect of the participant's distance to the blackboard on attention. First, the distribution of the variable was checked. The Kolmogorov-Smirnov test shows that "Attention-Time" followed a normal distribution (p=0.500), so the differences were analysed using ANOVA test. Different distances from the participant to the board have a significant impact on attention (p=0.012): the longer the distance, the lower the attention performance (Table 1).

Table 1. Significate differences between distance and attention by Spearman's correlation coefficient.

Variable	Distance to the blackboard	Mean Rank
Attention-Time	X	452.25
	X+0.6	440.13
	X+1.2	434.76

3.2 Distance to the blackboard and memory

The effect of the participant's distance to the blackboard on memory was also analysed. The Kolmogorov-Smirnov test shows that "Memory-Correct" followed a non-normal distribution (K-S, p=0.119), so the differences were also analysed using the Kruskal-Wallis test. However, different distances from the participant to the board do not have a significant impact on memory (p=0.261).

4 CONCLUSIONS

Analysis indicates that distance to the blackboard affects attention performance, but not memory. As for attention, it increases as the distance to the blackboard gets shorter. This suggests that it is possible to improve the performance of this cognitive function by modifying this variable. However, it should be noted that a more advanced study will be needed to determine the thresholds within which this property occurs. When this is determined, taking into account the results presented here, it may be an important action: regarding already built classrooms, it would not involve major transformations (as opposed, for example, to painting the walls of the classroom to apply a colour more suited to the cognitive functions); and regarding newly built classrooms, it would serve as criteria for setting their length. Thus, the results may be of interest to different profiles. For designers involved in these spaces, for educators interested in improving the cognitive abilities of their students by modifying the dynamics of their classes, and for researchers involved in how space can affect cognitive processes.

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REFERENCES

[1] R. Küller, "Architecture and emotions," in *Architecture for people*, B. Milkellides, Ed. London, UK: Studio Vista, 1980, pp. 87–100.

[2] A. V. Fisher, K. E. Godwin, and H. Seltman, "Visual environment, attention allocation, and learning in young children," *Psychol. Sci.*, vol. 25, no. 7, pp. 1362–1370, 2014.

[3] G. I. Earthman and L. Lemasters, "The impact of school buildings on student achievement and behavior," *PEB Exch.*, vol. 30, pp. 11–15, 1997.

[4] Z. Yang, B. Becerik-Gerber, and L. Mino, “A study on student perceptions of higher education classrooms: Impact of classroom attributes on student satisfaction and performance,” *Build. Environ.*, vol. 70, pp. 171–188, 2013.

[5] H. H. Choi, J. J. Van Merriënboer, and F. Paas, “Effects of the physical environment on cognitive load and learning: towards a new model of cognitive load,” *Educ. Psychol. Rev.*, vol. 26, no. 2, pp. 225–244, 2014.

[6] M. A. Read, A. I. Sugawara, and J. A. Brandt, “Impact of space and color in the physical environment on preschool children’s cooperative behavior,” *Environ. Behav.*, vol. 31, no. 3, pp. 413–428, 1999.

[7] K. Roskos and S. B. Neuman, “The classroom environment: First, last, and always,” *Read. Teach.*, vol. 65, no. 2, pp. 110–114, 2011.

[8] G. C. Marchand, N. M. Nardi, D. Reynolds, and S. Pamoukov, “The impact of the classroom built environment on student perceptions and learning,” *J. Environ. Psychol.*, vol. 40, pp. 187–197, 2014.

[9] J. Steuer, “Defining Virtual Reality: dimensions determining telepresence,” *J. Commun.*, vol. 42, no. 4, pp. 73–93, 1992.

[10] J. W. Smith, “Immersive Virtual Environment Technology to Supplement Environmental Perception, Preference and Behavior Research: A Review with Applications,” *Int. J. Environ. Res. Public Health*, vol. 12, no. 9, pp. 11486–11505, 2015.

[11] J. L. Higuera-Trujillo, J. López-Tarruella, and C. Llinares Millán, “Psychological and physiological human responses to simulated and real environments: A comparison between Photographs, 360° Panoramas, and Virtual Reality,” *Appl. Ergon.*, vol. 65, pp. 398–409, 2017.

[12] J. L. Higuera-Trujillo, C. Castellanos, and C. Llinares, “Educational centres design tools. Virtual reality for the study of attention and memory performance.,” in *INTED2020 Proceedings*, 2020, pp. 4362–4366.

[13] L. J. Seidman *et al.*, “A functional magnetic resonance imaging study of auditory vigilance with low and high information processing demand,” *Neuropsychology*, vol. 12, no. 4, pp. 505–518, 1998.

[14] M. S. Beato and E. Díez, “False recognition production indexes in Spanish for 60 DRM lists with three critical words,” *Behav. Res. Methods*, vol. 43, no. 2, pp. 499–507, 2011.

[15] M. Á. Alonso, Á. Fernández, E. Díez, and M. S. Beato, “Índices de producción de falso recuerdo y falso reconocimiento para 55 listas de palabras en castellano,” *Psicothema*, vol. 16, no. 3, pp. 357–362, 2004.