



IEEE VR  
SAINT-MALO, FRANCE  
March 8-12, 2025



# The Effect of Cognitive Load on Visual Search Tasks in Multisensory Virtual Environments

Jorge Pina<sup>1</sup>, Edurne Bernal-Berdun<sup>1</sup>, Daniel Martín<sup>1</sup>, Sandra Malpica<sup>2</sup>, Carmen Real<sup>1</sup>, Pablo Armañac-Julián<sup>1</sup>, Jesus Lazaro<sup>1</sup>, Alba Martín-Yebra<sup>1</sup>, Belen Masia<sup>1</sup>, Ana Serrano<sup>1</sup>

Universidad de Zaragoza – I3A, Spain<sup>1</sup>

Centro Universitario de la Defensa de Zaragoza – I3A, Spain<sup>2</sup>

Understanding cognitive load [1] and its impact in immersive, multisensory experiences is critical for task-oriented applications like training and education. We studied the effect of cognitive load on user performance on a **visual search task**, performed on its own or alongside a secondary, **auditory task**. This effect was tested for two search areas. We were inspired by the work of Das et al. [2] on traditional screens.

## ➤ Experimental design

The experiment consisted of two blocks, one for a **90°** search area and one for a **360°** search area. Block order was fixed, starting with 90°, so participants became familiar with the simpler environment before progressing to the 360° search area. For each block, users completed two segments of different **cognitive levels** in random order.

## ➤ Experiment conditions

We explore two factors: **cognitive load** and **search area**. Search area is divided into **90°** and **360°**. Cognitive load is divided in two levels: **high** and **low** cognitive load.

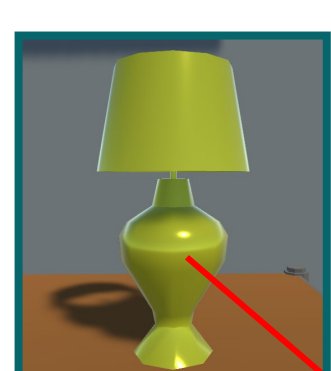
Segments labeled as low cognitive load only asked the user to perform the visual search task, while high cognitive load segments also presented a secondary audio task they had to perform simultaneously.



- **90° Search area** Objects were presented only in one wall for this search area. Users were instructed to face it before starting, and all the target objects were constantly inside their field of view (FoV).



- **360° Search area** Objects could appear in all four walls for this search area. Users were told that they would have to rotate in order to find the target objects around the room.



- **Visual search task** Users were asked to find a target object highlighted golden and select it with the trigger of the controller. After that, another object was randomly highlighted. The number of target objects found in the time of the segment was considered their performance.

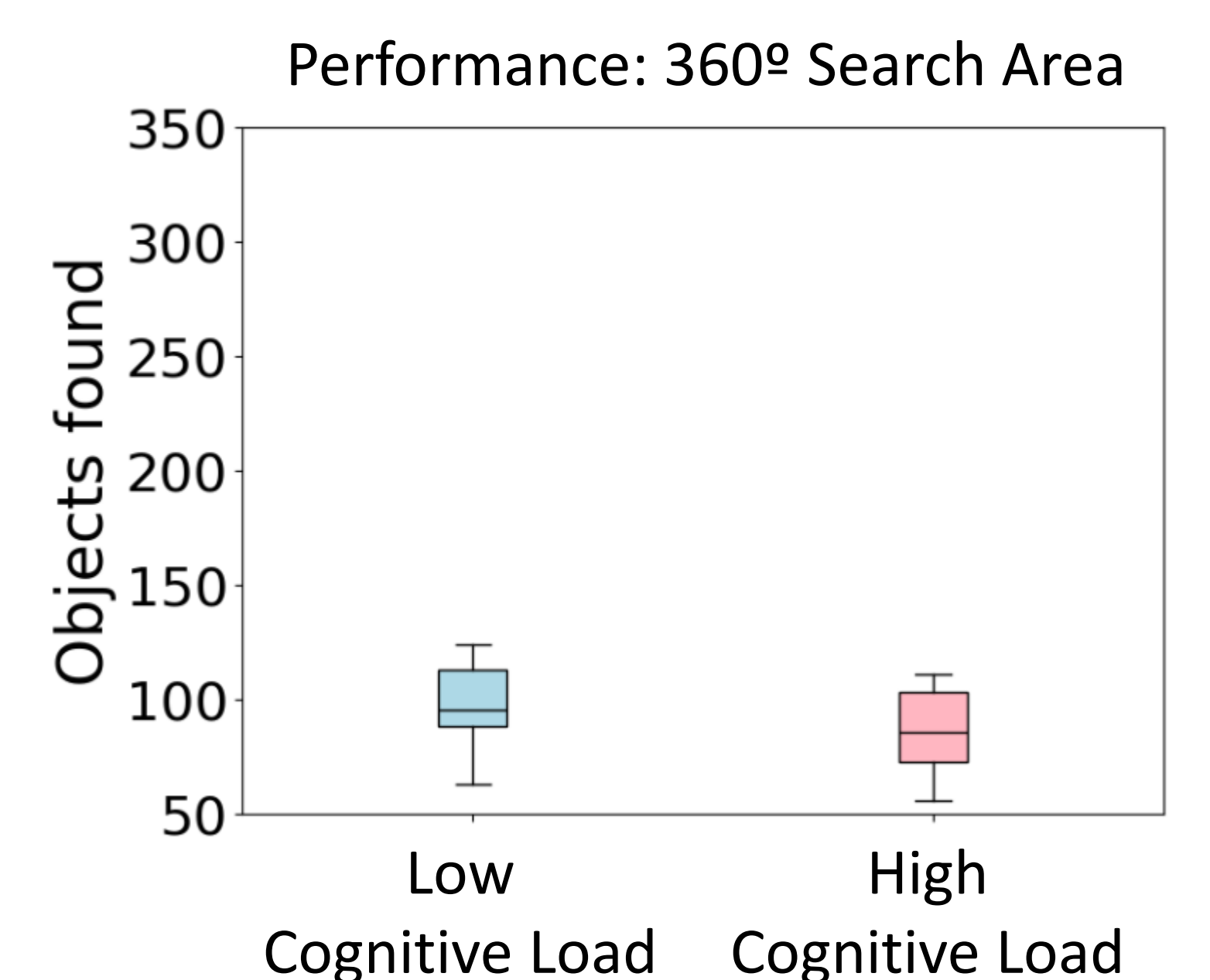
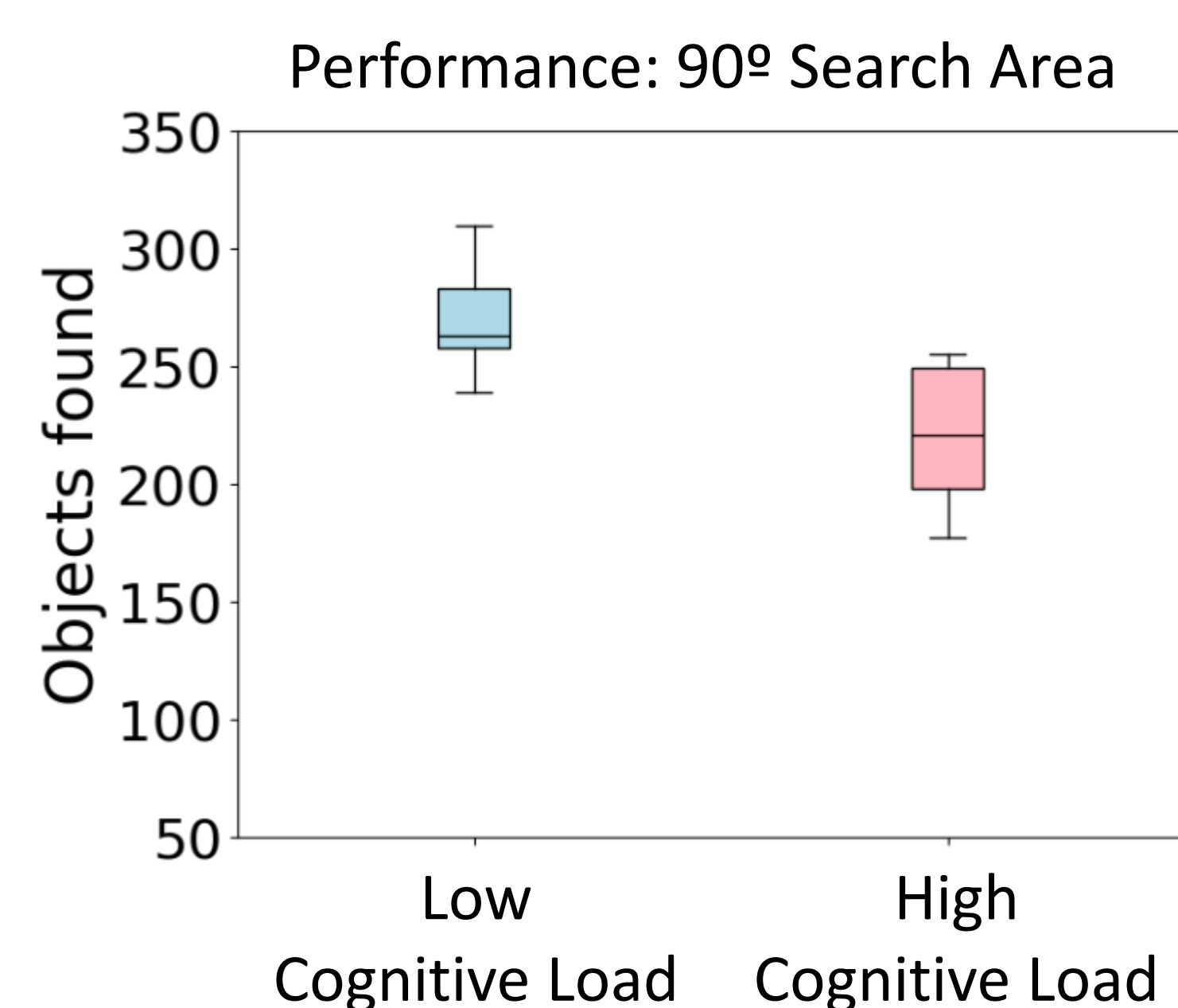


- **Auditory task** Consisted of an audio of a story played during the segment, filled with numbers the users had to react to. Users were asked to press the A button as fast as possible each time they heard an odd number. Accuracy was measured as the percentage of odd numbers pressed on time.

## ➤ Results

Our preliminary results show a **decline in task performance** with increased cognitive load, but with different trends between the 90° and 360° cases. While direct comparisons between search areas were not conducted due to their fixed order, the presence of the auditory task seemed to hinder users' ability to complete the main task. Considering that both tasks are independent and present different modalities, this trend could indicate the strong effect cognitive overload can have in immersive environments.

A mean **accuracy of over 85%** for the secondary task regarding odd numbers correctly detected ensured that users were not neglecting it, further indicating its notable effect.

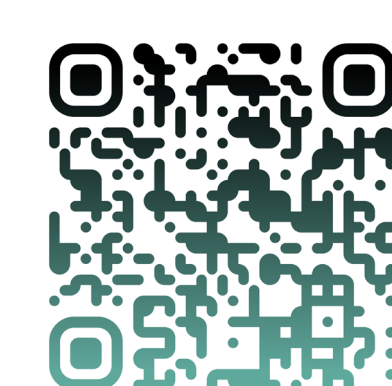


## Acknowledgments:

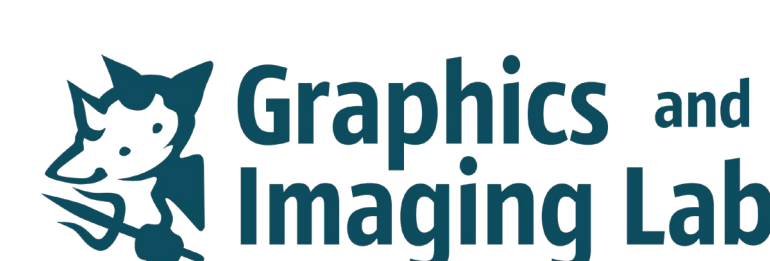
This research was funded by grant PID2022-141539NB-I00, funded by MICIU/AEI/10.13039/501100011033 and by ERDF, EU, and by the Aragon Institute for Engineering Research (I3A) through the Impulso program. Additionally, J. Pina was supported by an FPI predoctoral grant (PRE2023-UZ-16) and E. Bernal-Berdun by a Gobierno de Aragón predoctoral grant (2021-2025).

## References:

1. J. Sweller. Cognitive load during problem solving: Effects on learning. Cognitive Science, 1988.
2. A. Das, Z. Wu, I. Skrjanec, and A. M. Feit. Shifting focus with hc-eye: Exploring the dynamics of visual highlighting and cognitive load on user attention and saliency prediction. Proc. ACM Human-Computer Interaction, 2024



Project page



Instituto Universitario de Investigación en Ingeniería de Aragón  
Universidad Zaragoza



IEEE



IEEE COMPUTER SOCIETY



VGTC

Unira