# Memory Evaluation Through 360° Technologies: Preliminary Study with Spanish Population


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***Abstract*—Episodic memory is essential to effectively perform numerous everyday life activities. The current work is focused to investigate the potentiality of 360° technologies in memory evaluation. A preliminary study was developed to investigate if immersive 360° environment could facilitate encoding and recognition memory in comparison to non-immersive 360° one. Results showed that immersive condition could be a potential tool to strengthen memory ability.**



***Keywords—episodic memory, 360° technology, memory assessment, preliminary study.***


## I. INTRODUCTION

Episodic memory is essential to effectively perform numerous everyday life activities and it enables human beings to consciously recall past experience along with their spatial and temporal contexts [1]. From the point of view of a clinical and neuropsychological assessment, an episodic memory task typically follows two steps design. First, during the study phase, a to-be-learned material is presented to the participant, often with an instruction to intentionally memorize it. Second, at the test phase, the participant is asked to remember the studied material during a free recall, cued recall, or even a yes/no recognition task. Several paper and pencil-based memory tests have been built up following this procedure such as the renowned California Verbal Learning Test [2].

Virtual Reality (VR) is growing exponentially as a tool for the study of several cognitive functions as memory. Some authors have pointed out that VR-based rehabilitation methods have several important benefits when compared to traditional methods: VR settings, although involving controlled environments, are more ecologically valid; patients can receive immediate dynamic feedback; training involves progressive learning, repetition, and setting and task customization according to users' requirements; and there are no physical consequences from errors [3]. Moreover, the sense of presence felt by participants during the exposition can facilitate memory encoding [4].

One recent trend in technology field is the 360° technology. This technology records a circular fisheye view of the surroundings; it is affordable and does not require any specific technical skills to be used. Furthermore, 360° apparatus and software are easier to use for both researcher and user. For example, users can actively view the realistic 360° panoramas by either moving or rotating a non-immersive device or by turning their head if they are using an immersive support (i.e., VR headset) [5]. On the other side, the weakness point of 360° technology is the impossibility to actively navigate inside the environment or interact with the objects. The 360° technologies could be categorized in immersive and non-immersive. The difference stands in the point of view. Through immersive 360° technology, participants feel as they are inside the environment thanks to the VR headset support. Participants con look around in first perspective. Through no-immersive, participants are only observer without the feeling to be inside the environment (or lower than the immersive one). Follow this point, the current work is a preliminary research to study the potentiality of 360° technologies in memory evaluation, following a previous work on this field [6]. In particular, we aim to evaluate if 360° immersive environment is more efficacious on coding and recognition memory task than a non-immersive condition. The project was accepted by the ethical committee of Valencia University (nº H1543407702114).

## II. METHOD

### A. Procedure

The experiment took place at Valencia University into the Department of Psychology. Participants were invited to sit on a swivel chair in the room where the experiment took place to give them the possibility to comfortably watch the 360º environments. After consenting, participants start the experiment divided in three parts: (a) encoding phase, (b) recall phase, and (c) recognition phase. During the encoding phase, participants look at two 360° pictures for 50 seconds each (bedroom A from an immersive technology and bedroom B from a non-immersive) and to memorize all the objects contained in the rooms. Participants were randomly assigned to two within conditions, 10 for each one: Group 1 looked first pictures A (immersive) and then picture B (no-immersive) and Group 2 looked first picture B (no-immersive) and then picture A (immersive). Later the counterbalancing method was made to evaluate the difference between immersive and no immersive conditions. Participants looked at the 360° pictures using two different systems: bedroom A through an Apple iPhone 6 mounted on a VR headset and bedroom B a Samsung iPad. Both systems provided the opportunity to view the 360° pictures, both showed to participants through the mobile app VR Player. During the recall phase, participants were asked to list all the objects they saw after watching bedroom A and bedroom B; researchers checked on a list of items what participants recalled. During the recognition phase, a 10-minute delay following the vision of the first room, participants from both groups were asked to recognize all the objects they saw in the first picture (bedroom A or B depending on the condition) from a written list.

### B. 360° enviroment

The two 360° pictures of a bedroom containing two different sets of common household items. Bedroom A and bedroom B had five common objects (i.e., bed, desk, PC, mirror and wardrobe) and five complementary objects each.


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Bedroom A (Fig. 1) had jeans, shoes, bottle, painting, and backpack, and bedroom B (Fig. 2) had t-shirt, flip-flops, vase, photo, and luggage. Complementary objects in both bedrooms were equivalent in terms of verbal and visual association norms: for example, the bottle in bedroom A was replaced with a vase in bedroom B. To generate the 360 pictures, was used LG360-105 camera and the LG 360 viewer software.

Fig. 1. Bedroom A

Fig. 2. Bedroom B

### C. Participants

20 participants (9 females, aged from 18-40 years old)) were recruited among Valencia University students 12 participants were undergraduate students (60%), 5 with master's degree (25%) and 3 PhD students (15%).

### D. Instruments

*Memory task*

Participants, after look at the 2 pictures (immersive and non-immersive), were asked to recall as many items as possible. Researcher note all the items in the written list. 10 minutes later the 2 exposition, participants have to complete the recognition task and mark, on a written list, all the objects that they remember of the first picture they watched (bedroom A for group 1 and Bedroom B for group 2).

*Simulator Sickness Questionnaire*

The Simulator Sickness Questionnaire is a 16-item questionnaire that measures the severity of sickness induced by the immersive 360° condition.

*Memory Failure of Everyday Questionnaire*

The questionnaire is a 28 items questionnaire that measures memory forgetfulness in daily life.

*Tech Ability*

The questionnaire is composed by 5 questions that investigate the technology ability of participants, especially their experience and usability with 360 tehnology.

## III. Results

All participants did not have specific memory problem (mean score 40.85 (SD=5.59)) and they have high tech ability (mean score 13.35 (SD=2)). Moreover, participants did not show any cybersickness problems (mean score nausea factor 11.35 (SD=2.87) and mean score oculomotor factor 11.80 (SD=2.89)). Furthermore, after counterbalance the conditions, paired t-test was carried out in order to analyze the differences in free recall task. Results revealed no significant difference between conditions both for "target recall score" $t(18) = -.44$, $p = 0.66$ and "common recall score" $t(18) = -.20$, $p = 0.84$. Furthermore, independent t-test was carried out to evaluate differences between conditions for the recognition task. Results showed a significant difference in "target recognition scores" for immersive condition, $t(18) = 2.14$, $p = 0.46$. However, there was no significant differences between groups on "common recognition scores", $t(18) = -0.45$, $p = .66$.

## IV. Discussion

In the last decade, several studies have shown the importance of VR to evaluate memory perform. So far, there are few studies that adopt 360º technologies to evaluate cognition functions. The current study was a preliminary research to investigate the potentiality of 360º immersive technology to strengthen episodic memory. For the study, we adopted a counterbalanced design to avoid the carryover effect because participants perform in more than one conditions, immersive and no-immersive, and the first exposition makes easer to remember the second one. Preliminary results showed a significant difference between immersive and no-immersive conditions, but only for the recognition target task. Next work is focused to increase the sample power including participants with memory impairment.

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