Topic: Virtual-reality monitoring - How to distinguish between real vs VR memories

PUTIAN YUAN, IP-Paris
SALMA CHANA, Telecom Paris
KARIM FREM, Telecom Paris

Virtual reality is a modern technology that attempts to provide an immersive experience in an artificial environment. As the technology improves, the experience becomes more realistic, resulting in a serious problem: the production of false memories due to source memory confusion, known as the "virtual-reality monitoring" failure. Therefore, we propose a possible solution to mitigate the confusion of memory sources in a VR environment by adding a visual loading effect into the scene. The visual effect consists of two steps, first the wrapper dissolves and then the model appears part by part. To test whether our solution works or not, we conducted an experiment with four participants and we observed that our solution somehow worked, but only if the manipulation was involved.

Additional Key Words and Phrases: Source monitoring, Virtual reality, Memory, Visual effect

1 INTRODUCTION

Source confusion memory is a cognitive psychology problem that affects the ability to correctly identify the source or the context of a given event. It occurs when a person does not remember the origin of certain memories or wrongly attributes them to a different context. This type of memory distortion is very common and is often encoutered when we confuse imaginary events (or dreams) with real ones.To understand the causes of this type of distortion, we need to understand how human memory is formed. According to source monitoring framework [1], most important memory characteristics are :

- **Sensory/Perceptual information** :involves interpreting sensory informations like sounds (hearing), color/shape/size..(vision), texture(touch).
- **Contextual information** : includes spatial and temporal elements.
- **Affective information**: refers to the emotional reactions experienced during the event
- **Cognitive operations** :all cognitive processes, such as records of organizing, elaborating, retrieving, and identifying, that were made when the memory was formed.

Considering these findings and the fact that virtual reality provides a context with all the temporal, visual, and spatial elements that can be found in the real world, the risk of confusing the source of a memory between the real and virtual world is very high. Since the virtual world is a simulation of the real world and details captured in VR are known to be from the real world, so our brains can be easily fooled and stored with a "real world context" label. This problem can be solved if we introduce intrusive elements into the virtual world. These elements will then be stored in memory, and when the brain remembers the event, it will also remember the intrusive element. This is like adding a dividing line between the two environments.

Based on [1], we have :

> In general, source-monitoring attributions should be relatively easy and accurate when the event memory in question is richly detailed, its attributes are uniquely characteristic of its source, and appropriate decision processes and criteria are used during remembering.

1.1 Hypothesis :

(1) Adding an intrusive element to the VR context attract the brain's attention.
(2) People can easily remember object with a large size and a lot of details.
(3) Time affects the ability to remember.
(4) Object manipulation helps to identify the context.

2 PROPOSED PROTECTION MECHANISMS AGAINST SOURCE CONFUSION:

Considering that the three senses (Vision, hearing, touch) are responsible for the formation of memories, we have proposed solutions for each sense :

(a) Vision :
The first solution : Adding visual messages, for example showing "This is a VR experiment ", "This is not real" ...
The second solution : Adding a floating character (pokémon characters) in front of the user.
The third solution : Adding a bouncing ball .
The fourth solution : Reshape the controller's hand
The fifth solution : Adding a special loading visual effect.

(b) Hearing :
The first solution : Adding a voice warning message.
The second solution : Filtering the sounds.

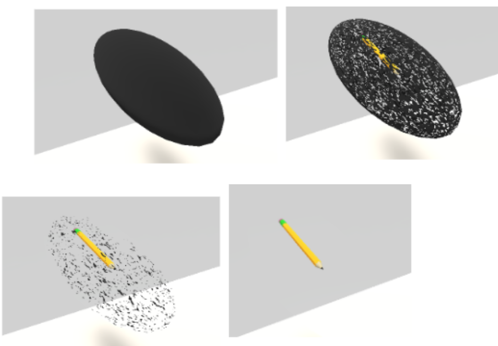
(c) Touch :
The first solution : Make controllers vibrate if the user touches a static object.
The second solution : Manipulate objects.

2.1 Final solutions:

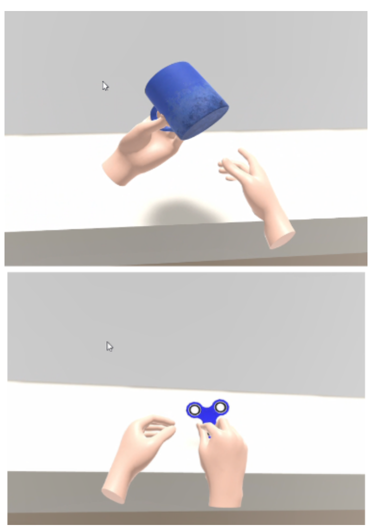
After a long discussion with our two supervisors we finally chose to combine two solution and implement them:

- Adding a special visual effect when loading objects to the scen : Our solution is inspired from the VR film "Goliath:

Playing With Reality".
In this video, we can see the transition between the ordinary real world and another imaginary world is made by a visual dissolving effect. So we decided to apply the same principle in our solution so that the user can see all the loading phases of a given object with a visual dissolution effect around it.



- Manipulate objects : We think that if the participant has the opportunity to manipulate a given object, he or she will be able to capture more details about that object and therefore avoid attributing it to a different context.



2.2 Implementation:

Pseudo shader code written in GLSL:

```
in vec2 uvCord;
uniform sampler2D noiseTex;
uniform float threshold;

void main(){
  float value=texture(noiseTex,uvCord).r;
  if(value<=threshold){discard;}
  // other codes
}
```

We select a noise texture and pass it into our shader, and pass the "threshold" variable as well. Then use model's uv coordinate to get a value from this texture, and use it and "threshold" value to do the test. Discard the pixel which doesn't pass this test.

[Project on github repository link]

3 EXPERIMENT :

Our experiment is inspired from rubo's experiment, it's made of two parts : The first part without our solution and the second part with it.

3.1 The environement :

We have ran our experiment on Friday 24/06/2022, in the lab 4D12 : We have recreated the same environement in VR :

3.2 The experiment steps :

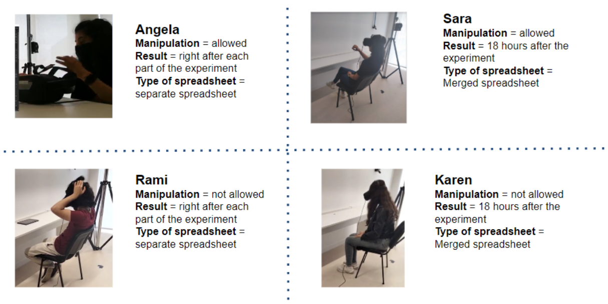
(1) Set up experiment environment (configure guardian in VR device, virtual table alignment and etc).
(2) Debrief the participant about the experiment, explain everything to them.
(3) The participant sits down on a chair in front of a table.
(4) We start off with a virtual object that will be shown for 10 seconds.
(5) Place real object in front of them at the same time.
(6) Removes headset when they hear the alarm after 10 seconds.
(7) Check real object.
(8) Put headset back on after they hear the alarm after 10 seconds.
(9) After they finish with all the items the participant was asked to fill in a spreadsheet with all the objects names in it and say whether they're real, virtual, how confident they are with the answer.

3.3 The experiment objects:

In our experiment, we used 26 objects: 14 in the first part, and 12 in the second. All the objects are office objects, because we thought that they were usual items and that they would be easily identified by our participants.

3.4 The participants :

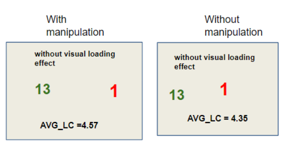
Through our experiment, we want to test all the hypotheses we made at the beginning. Since we only had four participants, we divided them into multiple subsets as shown:



4 RESULTS AND COMMENTS:

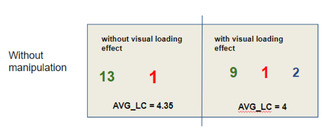
To effectively interpret the spreadsheets completed by the participants, we calculate the number of false, correct, [don't know] responses and the average level of confidence. The following image summarizes the final results:

4.1 Object manipulation :

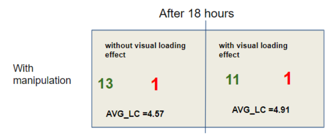


We can notice that participants who were allowed to manipulate the objects remember the seen objects with a high level of confidence. This is normal because manipulation allows for more detail to be captured and therefore better recall.

4.2 Loading visual effect:

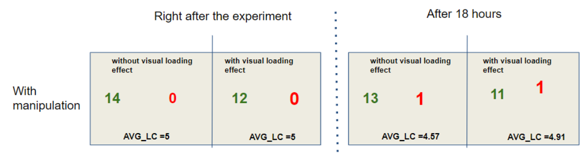


From the results obtained, we see that adding this special visual effect does not affect the number of errors (we always get one error), but it confuses the participants and makes them forget some objects (we got two "I don't know" responses). Some participants stated that they focused more on the visual effect and forgot the model in question.



As we can see, participants with both the manipulation effect and the loading effect have the highest level of confidence, but the number of errors does not change. Therefore, loading effect may be acceptable as a solution if combined with the manipulation.

4.3 Time and final result :



As expected, participant who fill the spreadsheet 20 mins after the experiment manage to get perfect score with high level of confidence.

4.4 The size and the details of models :

When reviewing the errors made by the participants, we find that the common errors were :

(1) Key.
(2) Remote control.
(3) Speaker.

The common point between all these objects: They are all small and not very detailed. Similarly, when we asked participants which objects they remembered most, they responded with "lamp" and "keyboard," which are large in size and/or rich in details.

5 CONCLUSIONS:

The experiment did not work as expected, we could not prove whether our solution fulfilled its purpose or not. We think in future work we can improve the following points:

(1) Have enough participants.
(2) Have more objects (real and virtual).
(3) Have more realistic virtual environment and objects.

REFERENCES

[1] M. K. Johnson, S. Hashtroudi, and D. S. Lindsay, "Source monitoring." *Psychological bulletin*, vol. 114 1, pp. 3–28, 1993.