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# Virtual Location Changes in Recall

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# Virtual Location Changes and Improvement in Recall

**Abstract**

Word list recall was investigated comparing participants with rapidly changing local contextual cues to those with relatively stable cues. The word lists were presented on a standard computer screen. The level of cue change was manipulated using a multi-user virtual environment in which one group of participants moved through the series of stimuli while participants in the second condition remained in one location. Participants viewing words with changing contextual cues recalled more words than those whose words were presented with an unchanging background (Stationary (M = 7.57, SD = 3.18), Changing (M = 10.42, SD = 2.82), $F(1,26)=6.33$, $p = .02$). The findings are congruent with traditional memory studies in which environmental cues were changed by presenting stimuli in different rooms for learning and recall.

*Keywords*: Virtual Reality, Environmental Context, Recall

## Virtual Location Changes and Improvement in Recall

The effects of environmental context on memory have been found to be subtle but consistent (Smith, S. & Vella, E., 2001). There are two relevant aspects of environmental cueing. The global environment is usually considered to be cues that are experienced during the experiment but extraneous to the focus of attention while the stimuli are being presented. Local environmental cues are ones that are inevitably processed during stimulus presentation (Glenberg, 1979, Brockmole, et al, 2006). State dependent learning refers to the effects of internal cues such as drug states or mood which are present during encoding and retrieval (Eich, 1980; 1995).

Environmental context has traditionally been manipulated by presenting stimuli in one room and recalling or learning interfering materials in a different room (Kanak & Stevens, 1984; Smith, 1979). Dallett and Wilcox (1968) produced a contrast in contexts by comparing participants who had an oddly decorated box on their heads to those receiving a more normal presentation environment. Studies as long ago as Underwood, Ham, and Ekstrand (1962) manipulated the local context by putting colored borders of construction paper around the stimuli. More recently, Stevens and Kanak (1993) manipulated local context by placing each word in a serial learning list in a different spatial location on the monitor. In that study, when the learning of stimuli all placed in the center of the screen was compared to stimuli with non-overlapping positions, the words placed in unique locations were learned 30% faster. In addition, studies in environmental context have shown that after learning multiple stimuli in one environment, a change in learning environments can produce a release from retroactive interference (Greenspoon & Ranyard, 1957).

Many schools are investigating Multi-User Virtual Environments (MUVE) for educational purposes (Gamage, V., et al, 2011; Naya, V & Ibanez, L, 2014). One approach to the presentation of information in a MUVE is to simulate a real-life classroom with a slide screen and a lecturer. The ability to control environmental cues in this medium allows for information presentation in a way that allows for the purposeful manipulation of cues. Many aspects of the environmental cues can be varied for each item to be learned by having a participant encounter learning materials while moving through a simulated three-dimensional environment. Stevens and Kanak (1993) achieved faster learning by manipulating only the location of stimuli on a white screen. A MUVE allows the easy manipulation of location on the two-dimensional screen as well as control of perspective and other visual cues which can simulate differences in the third dimension.

The current study was designed to investigate the impact of manipulating environmental cues during learning. Participants were engaged in pairs. They were in different physical rooms, but both controlled avatars in the same general virtual learning environment. One participant controlled an avatar which remained stationary in front of a presentation screen, simulating a presentation in a classroom viewed from a stationary position. At the same time, a second avatar was placed on a path on which the learning stimuli, individual words, would be encountered one at a time (See Figure 1). All stimuli appeared on a white background in the center of a simulated screen. By comparing the results of the stationary learners to the ones who moved through a series of visual cues to reach each word, the impact of dramatically changing environmental cues could be assessed. The hypothesis was that participants who encountered a varied local context would remember more words than the participants who saw the words in an unchanging local context.

## Method

### Participants

Twenty-eight undergraduate psychology students participated. Included were 27 females and 1 male with a mean age of 18.7 years. Nine participants were African American, 15 were Caucasian, and 3 were Hispanic. The participants volunteered to be part of the study. Participants were treated in accordance with the principles of the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 1992).

### Equipment and Materials

Two computers with 19 in. monitors were used to simultaneously access the virtual environment of Second Life. Two avatars were used that were created for this purpose. A presentation area was created in which an avatar could walk along a prescribed path to encounter the learning stimuli, one at a time, always in the same order. Colorful walls and distinctive decorations were used to produce visual changes in the environment as the avatar progressed through the list of words. One avatar of the pair was guided to a chair and seated in front of a virtual screen. Upon being seated, the virtual screen covered most of the actual computer screen, hence, those in the stationary group were viewing single words on a white background.

The second avatar walked through a prescribed path on which there was one viewing station for each word. For the avatar following the path, there was a control panel for each word. The virtual screens each started with a single asterisk displayed. The control panels allowed the participant to bring up one word at each location for viewing and then return it to a display with three asterisks before proceeding to the next stimulus. The seated avatar's screen was controlled by the actions of the moving avatar such that both participants saw the same words and asterisks in the same order and for the same lengths of time.

**Design and Procedure**

Participants were tested in yoked pairs. Each participant controlled an avatar in a MUVE. One avatar walked through a path on which there was one screen and a control panel for each word. The control panel was used to bring up each word and then return it to a slide with three asterisks. This avatar controlled the timing of the presentations for both participants. These participants were in the Changing group. At the same time, a second avatar was seated in front of a virtual screen which covered most of the actual computer screen. These participants were in the Stationary group. The walking path was designed with colorful walls and decorations designed to maximize the changes in visual cues as the avatar progressed through the stimulus list. The fact that the Stationary avatar's screen was controlled by the control panels used by the Changing avatar meant that both participants saw the same words in the same order and for the same lengths of time. The list was presented three times in each session. After each session, a recall sheet with a box for each word was given to the participant and the participant was asked to reproduce the stimulus list in order.

## Results

The data was analyzed using a 2X3 mixed ANOVA. Addressing the dependent variable of serial recall, the main effect of Trials was significant ($F(2, 52)=52.42$, $p < .01$. The main effect of Type, comparing the Stationary condition to the Changing condition was not significant ($F(2, 52)=1.72$, $p = .20$). There was a significant interaction of those two factors ($F(2, 52)=4.01$, $p = .02$. The recall of the Stationary group was compared to the recall of the Changing cues group at each of the three trials. It was found that there was a significant difference in recall only on the third trial. For trial one, the Stationary recall ($M = 3.71$, $SD = 2.13$) and the Changing recall ($M = 3.43$, $SD = 2.44$) did not differ significantly ($F(1, 26)=0.109$). Similarly, the means

in trial two, Stationary (M = 7.5, SD = 2.71) did not differ from the Changing group (M = 8.36 SD = 3.70), ($F(1, 26) = 0.49$, $p = 0.49$). On the third and final trial, there was a significant difference between the Stationary group (M = 7.57, SD = 3.18) and the Changing group (M = 10.42, SD = 2.82), $F(1,26)=6.33$, $p = .02$).

## Discussion

The fact that the Trials factor was significant was not related to the hypothesis and the implication is that more presentations of the materials resulted in greater recall. The fact that the main effect of Type was not significant reflects the fact that this was a repeated measures task. There was not a significant difference in the first two trials, but the significant interaction reflects the fact that the third trial results were significant.

The prediction was that varied cues that were external to the learning materials (white slides with one word on each slide) would produce recall cues which were superior to those in the condition in which the cues external to the learning materials did not change. The fact that there were not differences in recall on the first two trials may reflect the fact that the use of an avatar in this type of display was not familiar to many participants and it took some time to become comfortable with controlling the avatar and to focus on the task.

There is a long history of the manipulation of cues in learning materials. Greek scholars did not use spaces between words or punctuation marks (Houston, 2015). Now, textbooks commonly use boldface text, color, italics, and a variety of strategies to facilitate the processing of the information. One of the capabilities that a MUVE adds a new set of cues to the presentation of information, those used in depth perception. The current study was suggested by the mnemonic device of the Method of Loci (Yates, 1966; McCabe, 2015). The original use of

the Method of Loci involved physically walking around an area to establish a mental image to use when memorizing a series of items.

The traditional use of the Method of Loci is an intentional, effortful process. This study demonstrated the usefulness of changing environmental cues in the environment to produce an increase in memory performance without an increase in effortful processing. Just as the formatting of textbooks is designed to enhance processing, the formatting of depth perception cues and simulating moving through those cues can produce better recall. Directions for further research could include a similar task but comparing passive to intentional use. While recall improvement was achieved with no intentional use of the cue changes, it is possible that additional improvement could result from instructions to attend to the cues and to think about them during recall.

Visual cues, from spacing and punctuation to depth perception cues on a flat screen have been useful to enhance information processing. Technology has provided another type of hardware, virtual reality headsets that provide a richer set of depth and movement cues. Techniques that provide an improvement in recall in a flat, simulated 3D environment may well work as well as flat screen simulation and may provide additional opportunities for cue manipulation. Such methods are currently being used in educational settings (LSU Online, 2020).

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## Appendix


Figure 1. *Avatar In Changing Cues Condition (left) and Stationary Condition (right)*