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The impact of environmental cues on learning in a virtual world

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*Abstract.* Virtual world software was used to examine the impact of environmental context on the learning of word lists. In the first experiment participants either viewed the learning materials by guiding an avatar through a path with a variety of environmental cues, or the avatar sat in front of a screen and watched the stimuli. The mean serial recall of the path group was greater than the mean of the seated group. In the second experiment all participants guided an avatar along a path containing stimuli. The task was to learn the list to the point of getting all items correct on one trial. In one condition, the stimuli were presented along a white, featureless path while in the second condition the stimuli were presented along a simulated walk through a garden. The garden path group learned the list faster than the group whose stimuli were presented on a featureless white path. These findings suggest that the purposeful manipulation of some of the unique characteristics of virtual world software, such as the ability to rapidly change environmental cues, can be used for the online delivery of information in a way which results in better or faster learning.

Environmental context can be any type of cue present at learning that is not required to represent the information. This can range from the style and color of the font to characteristics of the environment such as the placement of windows and positioning of the furniture. Context has been manipulated in the physical world by procedures such as changing rooms between learning and recall (Smith, Glenberg, & Bjork, 1978), recalling above or under water (Martin & Aggleton, 1993), and learning with the participants’ heads in a box then recalling outside the box (Bilodeau & Schlosberg, 1951). Context can also be internal, such as in state dependent and mood-dependent recall (Eich, 1980). Another form of internal context is that of internal mental imagery. In Smith’s (1979) study participants were asked to draw the room before learning. This was to induce better encoding of the context. Instead of returning the participants to the learning room for recall, they were instructed to recall the room cues which facilitated the recall of the words learned in that room.

If all stimuli of a learning task are associated with one environment, reinstating those cues at recall can result in competition between the stimuli. This has been seen in experiments in which multiple lists were learned on one context and the last list was learned either in the same

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or a different context (Kanak & Stevens, 1984). Proactive Interference (PI) is reduced by providing a different, neutral context for the last list. Another way to prevent stimuli from interfering with each other is to present each stimulus in a different context. This was accomplished using multiple rooms for the experimental group while the control group learned the same words in a single room (Smith, 1982). While difficult in practical application, this can be accomplished quickly and easily in a virtual environment.

The first experiment in the current study compared an avatar in a single virtual room to an avatar walking through a path with many varied cues. The task was to recall the words in order after each of the three presentations of the list. The second experiment used a serial anticipation procedure and the avatars proceeded through the pathways displaying the lists until they had perfect performance on one trial. The hypothesis was that changing environmental cues would result in a reduction of interference. In the first experiment the stationary control group was compared to a group for which both visual and spatial cues were varied. In the second experiment both groups had varied spatial cues and the difference was in the distinctiveness of visual cues. Better recall in Experiment 1 and in faster learning in Experiment 2 support the hypothesis.

### Experiment 1

**Method**

**Participants.** The participants included 18 female students and 9 male students between the ages of 18 and 26 (M = 18.65, SD = 1.62) recruited from the introductory psychology classes at the University of Louisiana at Monroe.

**Equipment.** Stimuli were presented using personal computers with 18 in. LCD monitors displaying a virtual world program.

**Materials and Procedure.** The word list, chosen from the Paivio, Yuille, Madigan (1968) word norms, was composed of 12 words ranging in length from 5 to 9 letters with a mean imagery rating of 3.2 and a mean meaningfulness rating of 5.0. No two words in the list started with the same letter.

The avatars were either seated in front of a white rectangle on which the words were displayed, one at a time, or they walked through a path and encountered similar displays with the same words. The path was designed such that each word was surrounded by distinctly different visual cues. Participants were run in pairs, one sitting and one walking. The walking avatar controlled the presentation by clicking on a button to change the display from an asterisk to a word, then clicking it again to return the display to the asterisk. The display for the seated avatar mirrored the display of the walking avatar, causing them to see the words in the same order and for the same length of time. Each participant saw the list three times. After each presentation of the list the participants were given a data sheet with a space for each word and then asked to write all of the words in order.
Results and Discussion

At the end of the first presentation the mean recall of the seated group (SG) was 3.71 words, and the mean of the walking group (WG) was 3.43. After the second trial the SG mean recall was 7.50 and the WG mean was 8.36. There were no significant differences between groups in the first two trials. There was a significant difference between means after the completion of the third presentation of the words. The mean recall of the SG group was 7.57 and the mean of the WG group was 10.43, (F (1, 26) = 6.33, p = .02, η² = .196).

The superior serial recall supports the hypothesis that for the WG group, a change in environmental cues between the presentation of each word reduced the intralist interference at the time of recall.

Experiment 2

Method

Participants. The participants included 48 female students and 23 male students between the ages of 18 and 49 (M = 20.31, SD = 5.14) recruited from the introductory psychology classes at the University of Louisiana at Monroe.

Equipment. Stimuli were presented using personal computers with 18 in LCD monitors displaying a virtual world program.

Materials and Procedure. The word lists were chosen from the MRC Psycholinguistic Database (Clark, 1997). Word length ranged from 5 to 10 letters. The mean concreteness rating was 299 and the mean frequency rating was 31.0. Each list was composed of 15 word pairs. The words were arranged to produce A-B, A-C paired associate lists (dog-cat, dog-pig) and A-B, C-D control lists (dog-cat, horse-cow).

Participants were put in control of an avatar and given instructions in a practice area. The avatar displayed the stimulus word of the pair by walking onto a distinctive rectangle. Walking off of the rectangle displayed the stimulus and its associated response word. After walking the entire path and seeing all of the word pairs, the task of the participant was to say the response word upon seeing just the stimulus word. Participants repeated the path until they got all of the response words correct in one trial. All participants learned the A-B list first. For the List factor, the A-C list was the second list for half of the participants and the other half of the participants learned the C-D list as the second list. The Path factor was created by having half of each List group walk on a path that simulated a garden path and the other half of each group walked on a path that was white and featureless. The word order was the same in the garden and white paths.

Results and Discussion

The dependent variable was the number of trials it took to learn the list to a criterion of 100% correct on one trial. A 2 X 2 ANOVA was used to compare the two List conditions (A-C or C-D) and the two Path conditions (garden or white). The interaction was not significant, F(1,69)=1.43, p>.05. The main effect of List was not significant, F(1,69)=1.59, p>.05. There was a significant main effect for Path, F(1,69)=5.40, p=.02, η²=.07. The group which learned
while walking the garden path took fewer trials ($M=3.05$) than those walking the white path ($M=3.70$).

It is possible that the A-B, A-C list manipulation failed to produce an interference effect because of the varying spatial location cues inherent in the second list for both path types. While the white path was devoid of one type of contextual cues, there were still different spatial location cues for each word. However, the varied cues of the simulated garden path resulted in faster first list learning compared to participants who walked along a featureless white path.

**General Discussion**

Past research that varied learning contexts to reduce RI or PI changed the context between the learning of complete lists (Bilodeau & Schlosberg, 1951; Kanak & Stevens, 1984). In an analogous manipulation, the experiments reported here changed contexts between individual items. The participants were either seated or walking along a path in the first experiment. This varied both spatial location cues and the cues visible around the word display area. The fact that, in the first experiment, the group with the varied cues recalled more words than those sitting in front of a fixed display supports the hypothesis that when many stimuli are associated with the same contextual cues it can produce competition at the time of recall.

To investigate the generalizability of the first result, the second experiment used a different task, that of paired-associate serial learning. The second experiment was also designed to further isolate the cues responsible for the improvements in learning. By having one group walk along a path decorated like a garden while the other group walked through a stark white environment, both groups experienced changing spatial cues while the changes in the cues visible at the time of learning were greater for the garden path group than for the participants who learned while on the white path. In addition, the choice of the A-B, A-C two-list paradigm was to show that the expected interference in the A-C list would be reduced when the A-C list was learned in the more distinctive garden path presentation. However, the failure to find a difference between groups in the A-C list may indicate that, while the difference between a white environment and a colorful environment is important, the spatial cues of 'walking around' are also having an effect.

Virtual worlds are being used for many educational purposes from lecturing in a virtual classroom to builds in which an avatar explores a simulation or other type of immersive build, encountering information. Presenting information in a virtual world allows the manipulation of contextual cues in a way that is not possible in a regular classroom. Designing the information presentation environments such that each element of a presentation is associated with distinctively different cues can be one way to reduce interference and enhance learning.

**Virtual Worlds for Classrooms of the Future**

It is not practical to change rooms or redecorate rooms between classes in a real world classroom. It is also not possible to designate a large physical area for student exploration of a single lesson. In virtual world environments extensive environmental changes can be made almost instantly. The digital analog of large physical exploration areas are possible, practical, and only limited by computer memory. There are many things yet to be learned about the best ways to use virtual worlds in education, but the current study suggests that the purposeful manipulation of contextual cues can be a beneficial practice in the delivery of information online.
References


