◈ Research Paper

Effects of User Expectation on Independent Visual Background Efficacy

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Abstract

Prior to the Independent Visual Background(IVB) luminance control experiment, we studied that IVB could reduce the simulator sickness depending on subject's knowledge about the IVB (expectation group) or non-IVB (no expectation group). As results of experiments from 12 subjects, expectation group's RSSQ scores were similar, no matter IVB was present or not. However, non-expectation group's RSSQ scores were lower when the IVB were present. The result from this experiment confirms the findings of Duh (2001), that an IVB may alleviate SS. However this effect was found only at the expectation group. Failure to replicate Duh's results could be due to several factors, such as individual differences in response to the IVB and the low number of subjects (n=6) in the no expectation group.

1. Introduction

Previous research indicated that an Independent Visual Background(IVB) reduced balance disturbance (Duh, Parker, Furness, 2000), and simulator sickness (SS) (Duh, 2001) evoked by visual scene motion. We are interested in possible effects when subjects control IVB luminance. Instructions to subjects in a luminance control experiment would include expected effects of an IVB. Therefore, before undertaking a luminance control experiment, we first must understand effects of subjects' expectations.

2. Method

2.1 Subjects

7 women and 5 men, ages 20 to 40 were recruited from the Human Interface Technology Laboratory subject pool. No subjects reported a history of auditory disturbance, balance disorders, back problems, or high susceptibility to motion sickness. Subjects were paid $15/ hour. The protocol was approved by the University of Washington Human Subjects Review Committee.

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2.2 Apparatus

We used a Real Drive driving simulator (Illusion Technologies International, Inc.) including a full-size Saturn car (General Motors Company), 3 800 x 600 pixel Sony Superdata Multiscan VPH-1252Q projectors, and 3 230 x 175 cm screens. A virtual world (Crayolaland) was generated by the CAVE software library (developed at the EVL, University of Illinois, Chicago) using a Silicon Graphics Onyx2 system. Crayolaland is a cartoon world that includes a cabin, pond, flowerbeds, and a forest. Additional software permitted inputs from a controller and replay of prerecorded trajectories through Crayolaland. In addition to the Crayolaland scene, an IVB composed of 8 horizontal and 35 vertical grid lines was presented behind the Crayolaland mountains. The computer-generated images were presented on the three screens as a panoramic scene and subtended a 220 horizontal FOV. The scene was presented in stereo using CrystalEyes stereo glasses (StereoGraphics Inc.) that alternatively masked the left and right lenses.

2.3 Procedure

The independent variables were subjects' expectations (some subjects were told that the IVB should reduce motion sickness others were not; between subjects factor), and IVB (IVB present or absent; within subjects factor). Dependent variables were the RSSQ's (Kim, 1999) total, nausea, disorientation, and strain/confusion scores and the E2I (Lin et al., submitted).

The subjects were separated into two groups. 6 subjects did not know about expected effects of the IVB. 6 other subjects were told about expected effects. All subjects repeated the two IVB conditions twice each. Two subjects were randomly assigned to each of the 6 orders of the IVB conditions. (Orders were as follows: I, I, N, N; I, N, I, N; N, N, I, I; and so on, where I is IVB present and N is no IVB present.)

Before the each trial, subjects filled out the RSSQ to measure their baseline simulator sickness symptoms. Then they were exposed to a motion trajectory through Crayolaland for 2 minutes. After each exposure, they filled out the RSSQ and E2I. Between trials, subjects rested for at least 5 min or until any SS symptoms associated with the previous trial had returned to baseline. Total experiment time was almost 1 hour.

Instructions were as follows:

No Expectations Group.

> Welcome to the driving simulator! You are participating in a virtual environment experiment. We are investigating whether the virtual environment gives you a sense of presence, how strongly the virtual environment evokes a sense of "being there."This experiment includes 4 trials. During each trial, you will experience 2 minutes following a pre-recorded path through a virtual environment called Crayolaland. There will be slight differences in the virtual environment between trials. If you notice the differences, please let me know after each trail. After each trial, we will ask you several questions regarding your sense of presence. Since simulator sickness is a side effect of exposure to virtual environments, we will also ask you to tell us about any simulator sickness symptoms.

Expectations Group.

Welcome to the driving simulator! You are participating in a virtual environment experiment. We're trying to repeat the findings of previous experiments, which showed that an "independent visual background"reduced the amount simulator sickness that people sometimes experience in virtual environments. In this experiment, the independent visual background will be a stationary white grid that appears behind the mountains in the virtual environment called Crayolaland. We're also interested in how strongly the virtual environment evokes a sense presence of "being there."This experiment includes 4 trials. During each trial, you will experience 2 minutes following a pre-recorded path through the Crayolaland virtual environment. For some trials, the grid will be visible; for other trials it will be turned off. After each trial, we will ask you several questions regarding simulator sickness and your sense of presence.

3. Results

The results from this study are summarized in Tables 1 and 2 and Figure 1. In Table 1, the main effects of IVB, EXPECT(expectations) and SEQ(sequence) were not statistically significant. Only one interaction(IVB*EXPECT) was significant. However, observed power for all effects was low. Therefore, we pooled SEQ into the error term and reanalyzed the data, as shown in Table 2. This resulted in a clearer IVB*EXPECT interaction (see Figure 1).

As shown in Figure 1, SS scores were not different for the expectation and no-expectation groups when the IVB was absent. However, SS was greatly reduced for expectations group when the IVB was present.

Table 1. Tests of Within-Subjects Effects (Measure: Total Score of RSSQ)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Noncent. Parameter	Observed Power
IVB	180.487	1	180.487	2.033	.184	.169	2.033	.252
IVB * EXPECT	486.919	1	486.919	5.485	.041	.354	5.485	.562
Error(IVB)	887.697	10	88.770					
SEQ	56.556	1	56.556	1.143	.310	.103	1.143	.163
SEQ * EXPECT	8.717	1	8.717	.176	.684	.017	.176	.067
Error(SEQ)	494.921	10	49.492					
IVB * SEQ	3.902	1	3.902	.083	.779	.008	.083	.058
IVB * SEQ * EXPECT	113.074	1	113.074	2.403	.152	.194	2.403	.289
Error(IVB*SEQ)	470.647	10	47.065					

Computed using alpha = .05

In Table 2, interaction (IVB* EXPECT) was still significant and observed power increased to 0.731. Figure 1 is interaction of IVB and Group.

Table 2. Tests of Within-Subjects Effects(Measure: Total Score of RSSQ)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared	Noncent. Parameter	Observed Power
IVB	180.620	1	180.620	2.693	.115	.109	2.693	.348
IVB * EXPECT	486.831	1	486.831	7.259	.013	.248	7.259	.731
Error(IVB)	1475.377	22	67.063					

Computed using alpha = .05

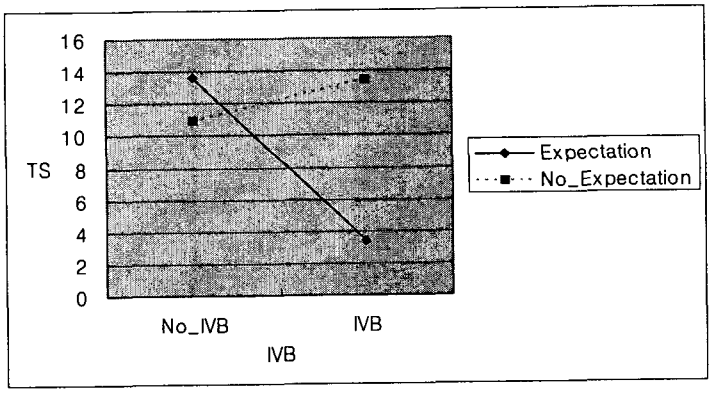

Figure 1. Total sickness scores as a function of IVB and Expectations.

During the post experiment debriefings, some of the subjects in the no expectations group reported some interesting phenomenon in terms of their perception of the scene motion. One subject described her experiences in the IVB conditions as follows.

> "I guessed that the grids made me more dizzy and sick. It waved weirdly, and I couldn't understand why it moved that way. I saw some butterflies and bees flying in it, and they were cute and interesting. I felt like the mountains, cabin, trees, and flowers were stationary. But, the grids moved very weirdly."

Another subject in this group reported a very similar experience in the IVB conditions. Both subjects perceived the IVB as moving in an "un-understandable"way, and they thought that this made them uncomfortable. Interestingly, these two people were the subjects who reported more SS symptoms in the IVB conditions than the no-IVB conditions. This phenomenon suggested induced motion of the IVB may increase SS for some subjects. In this situation, the IVB was perceived as another "moving object" in the scene rather than a "stationary background," and this "moving object" covered a very wide FOV, the whole scene. It seemed to move in a totally differently (or opposite) direction of the Crayolaland objects (as well as the reference axes of subjects), and very likely disturbed subjects'vection based on the Crayolaland motion.

4. Discussion

The results of this experiment partly confirmed the findings of Duh (2001), that an IVB may alleviate SS. However this effect was found only for the expectations group.

Failure to replicate Duh's results could be due to several factors including individual differences in reactions to the IVB. As noted above, some subjects reported at the Crayoland motion "induced" movement of the earth-fixed IVB. Some of these subjects reported that the IVB reduced their stability, it made them more rather than less sick. Perhaps these subjects found it difficult adopt the grid IVB as a rest frame (Prothero et al., 1999). A grid may be too ambiguous in the sense that it has no inherent stability, unlike, say, a tree or a wall. A grid has no properties that would readily be associated with the concept of a "background; "i.e., it lacks the properties of a real visual background. As an alternative to a grid, we will explore a more natural (background-like) IVB in future experiments. In addition, we should attempt to assess individual differences prospectively.

Individual differences in subjects' expectations regarding possible effects of an IVB may also have contributed to differences between the present study and the previous one. Because Duh did not specifically control subjects' expectations, the IVB effects reported by him may have been due to the IVB, subjects' expectations or both. If both the expectations group and the non-expectations group in this study had exhibited reduced SS, the potential confound in the Duh study would have been resolved. Unfortunately, the issue of subjects' expectations remains unresolved. This issue should be addressed in future studies.

Finally, differences between the study may have be due to the low number of subjects (6) in the no-expectations group.

We are interested in possible effects when subjects control IVB luminance. From the present experiment, we conclude that an IVB may alleviate simulator sickness when subjects expect it to.

References

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