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First Person and Third Person Perspective in Virtual Reality: Analysis of Cybersickness Symptoms

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Abstract
Advances in technology makes it easier to gain access to the virtual world. This has led to more and more application and games being targeted towards the virtual world. But with the growing popularity of the virtual world, cybersickness has grown in popularity as well. This study aims to evaluate the factors affecting cybersickness in the Virtual Reality (VR) environment. There are few factors causing the effect of cybersickness in VR like duration, field of view, speed, habituation, and susceptibility of said user. Those factors affect differently in first person perspective(1pp) and third person perspective(3pp). To measure the cybersickness, a Virtual Reality Questionnaire (VRSQ) measurement index is utilized. The experiment was conducted with the following settings. The participants consisted of 20 males and 4 females who never used VR before. They performed task using short games. It consisted in total of 4 tasks (2 types of game (action and adventure) x 2 perspective (1pp and 3pp) = 4 tasks). The Latin Square design was used to minimize the effect of order. Then, a questionnaire was conducted after each treatment. Paired Dependent T-Tests was performed to check if there are differences in oculomotor, disorientation and VRSQ total score. Finally, there was a significant difference in 1pp and 3pp in both games, third person perspective have significantly less cybersickness symptoms than first person perspective.

Keywords: cybersickness, perspective, virtual reality.

INTRODUCTION

Virtual Reality (VR) is a topic that is discussed quite often. Although VR is not a new technology by any means, with the start of mass production of Head Mounted Display (HMD), the approaching VR era is not easy to deny. This mass production was due to the start of increasing quality and falling prices of VR hardware which were very significant compared to the previous decade. Just like VR which is not a new technology, cybersickness or better known as visually induced motion sickness (VIMS) is also not a new problem, it has even been documented since 1970 (Young, 1978).

It is easy to assume that cybersickness exist because the incapability of hardware. Even if we resolved hardware issues and reduce lags from input to HMD, it still require time for information to be sent and therefore causing motion sickness (Rebenitsch, 2015). There are several kinds of different factor that could intensify the symptoms of cybersickness. There are studies which show that age is a big aspect that affect cybersickness (Brooks et al., 2010), as well as visual stimulation, exposure times, and exposure duration (Saredakis et al., 2020). While there is already several studies that try to reduce cybersickness symptoms (Jeon et al., 2020), there are not many studies that compares the difference of first person perspective (1pp) and third person perspective (3pp) in VR though there are study that compares the difference of both perspective in navigation task (Medeiros et al., 2018). As a method to measure the symptoms of cybersickness, a Virtual Reality Sickness Questionnaire (VRSQ) which was developed specifically for VR (Kim et al., 2018) is utilized.

MATERIALS AND METHODS

Virtual Reality Sickness Questionnaire (VRSQ)

To measure motion sickness in a simulator typically SSQ (Simulator sickness Questionnaire) is used. SSQ includes 16 symptoms that are divided into three main components. In this study VRSQ tools were selected since it is valid and reliable measure of cybersickness(Sevinc & Berkman, 2020) and also was used in very similar research (Jeon et al., 2020). VRSQ consists of nine symptoms (General discomfort, Fatigue, Eyestrain, Difficulty focusing, Headache, Fullness of head, Blurred vision, Dizzy (Eyes closed), Vertigo), which are divided into two factors oculomotor and disorientation (Table 1). VRSQ scores can be calculated using the following formula (Table 2).

Table 1. VRSQ Symptoms

VRSQ Symptom	Oculomotor	Disorientation
General Discomfort	O	
Fatigue	O	
Eyestrain	O	
Difficulty focusing	O	
Headache		O
Fullness of Head		O
Blurred Vision		O
Dizzy (Eyes Closed)		O
Vertigo		O
Total	(1)	(2)

Table 2. Computation Score of VRSQ

Components	Computation
Oculomotor	([1]/12) *100
Disorientation	([2]/15) *100
Total	(Oculomotor score + Disorientation score)/2

Paired Dependent T-test

The paired dependent t-test method was chosen because in this study there were only 2 groups, namely the first-person perspective and third person perspective in both adventure and action games test. The experiment for both groups also conducted at same person using a within-subject or repeated-measure design, which means both tests were carried twice to the same person.

To use paired dependent t-test, there are two condition that must be met, which is the variance between group must be homogeneous and the data for each group required to be normally distributed. The meaning of homogeneity is that a set of data to be analyzed comes from a population that are not too diverse. In this study, the Levene test was used to test the homogeneity of the results from first-person perspective and third -person perspective experiment. If the data is normally distributed, it can be assumed that the data can be used to represent the population. In this study, the Shapiro-Wilk normality test was used because the amount of data used was smaller than 50 data.

$$d_i = y_i - x_i \quad (1)$$

$$\bar{d} = \frac{\sum_{i=1}^{i} d_i}{n} \quad (2)$$

$$S_d = \sqrt{\frac{\sum(d_i - \bar{d})^2}{n-1}} \quad (3)$$

$$SE(\bar{d}) = \frac{S_d}{\sqrt{n}} \quad (4)$$

$$t = \frac{\bar{d}}{SE(\bar{d})} \quad (5)$$

After both conditions were met with sample of n there are few steps to carry out t-test. Let x = VRSQ score with first person perspective, y = VRSQ score with third person perspective. To the null hypothesis that the true mean difference is zero, the procedure are as follows. Calculate the difference between the two observations on each pair with equation 1, then calculate the mean difference with equation 2. Afterward calculate the standard deviation of the differences with equation 3 and use this to calculate the standard error of the mean difference using equation 4. Finally calculate the t-statistic with equation 5, then use it for comparison of your value for T to the $t_{(n-1)}$ distribution. This will give the p-value for the paired t-test.

Experimental design

The study group consisted of 20 males and 4 females (average age: 24.4 years old, standard deviation: 1.4 years old). Participants never used VR devices beforehand in their life. They also have no physical health problem or visually impaired. The experiment starts by explaining to the participants the context and purpose of the experiment. The informed consent also explained to the participants including the fact that 1) the questionnaire is anonymous, 2) the experiment will last at least 90 minutes, 3) if the participants had severe case of cybersickness, the participants could take a rest whenever they want to. The participants were asked to perform 4 tasks consisting of adventure game with first person perspective (adv1pp), adventure game with third person perspective (adv3pp), action game with first person perspective (act1pp) and action game with third person perspective (act3pp). The experiment lasted for approximately 90 minutes per two participants in one session. The two different games are to generalize the most popular VR games in the market which is action and adventure (Figure 1). In the action game the objective is to defeat skeletons with free form movement to maintain distance with the skeletons. In the adventure game the objective is to climb a mountain with vertical acceleration and instant deceleration when you stop. Both games using joystick-controlled movement and action (Figure 2).

(a)

(b)

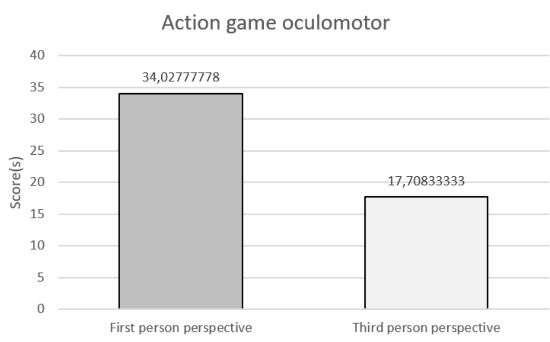
Figure 1. The game used (a) Action Game (b) Adventure Game

The VR environment was configured using Oculus Rift with resolution of 1280 x 800. To reduce the effect of order, the Latin Square design was used after grouping the participants into 4 groups. Finally, a questionnaire was conducted after every treatment through VRSQ using a 4-point Likert scale (0 = not at all, 1 = slightly, 2 = moderately, and 3 = very).

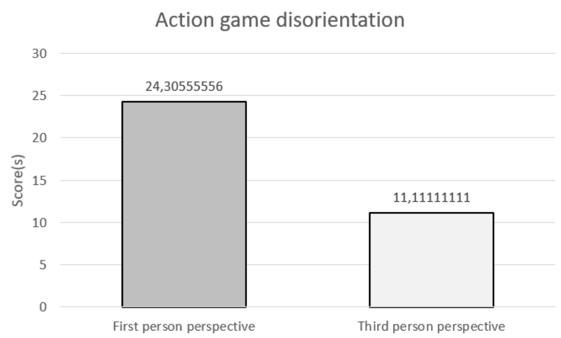
Figure 2. A participant wearing Oculus doing task

RESULT AND DISCUSSION

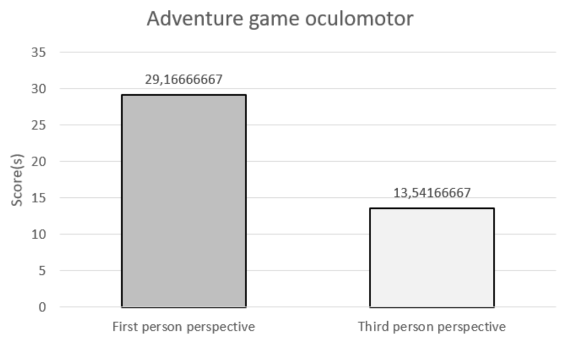
Analysis Once the experiment concluded, the data obtained in VRSQ are compared using the formula on Table 2. Figure 3 compares the average VRSQ score of all 4 tests for each dimension according to their perspectives. Although Figure 3 clearly show that there is a high difference in value, it does not necessarily indicate that there is a significant difference. To determine whether there is a significant difference from these treatments, a difference test analysis was performed using the paired dependent t-test.



(a)



(b)



(c)

(d)

Figure 3. VRSQ Scores for (a) Action game oculomotor (b) Action game disorientation (c) Adventure game oculomotor (d) Adventure game disorientation

As stated in previous chapter, Shapiro-Wilk test will be used to test the normality of the dataset and Levene test will be used to test the homogeneity of the paired dataset.

Table 3. Shapiro-Wilk test result

Game	Shapiro-Wilk		
	Statistic	Df	Sig.
adv1pp	.937	24	.138
adv3pp	.927	24	.082
act1pp	.920	24	.060
act3pp	.923	24	.069

The data is normally distributed if the significance value of the test results is more than 0.05, otherwise if the value is less than 0.05, the data is not normally distributed. Based on the result of normality test that has been carried out on Table 3, the significance value obtained is more than 0.05 (0.138 for adv1pp, 0.082 for adv3pp, 0.060 for act1pp and 0.069 for act3pp). Based on the test results, it can be concluded that the data is normally distributed.

Table 4. Levene test result

Game	Levene Statis-	Dfl	Df 2	Sig.
adv1pp x adv3pp	2.601	1	46	.114
act1pp x act3pp	3.5	1	46	.065

After the homogeneity test is conducted compare the significance value of the homogeneity test results with a significance level of 5% or 0.05 to find out whether the variant is homogeneous or not. The homogeneity test is carried out on the two games separately, because the paired dependent t-test will be tested separately. The significance value obtained from this homogeneity test as shown in Table 4 are greater than 0.05, namely 0.114 for the adventure games and 0.65 for the action games.

Table 5. Paired dependent t-test result

		Mean	Std Dev	Std error Mean	95% confidence interval of difference		t	df	Sig.
					lower	Upper			
Adventure	P1 & P3	7.25	5.06	1.03	5.11	9.39	7.02	23	.000
Action	P1 & P3	4.93	5.63	1.15	2.55	7.31	4.29	23	.000

There are three main prerequisites to reject the null hypothesis and conclude that there is a statistically significant difference. First, the t value is required to be greater than the critical value. In the Student's t distribution table, the critical value of df23 is 2.069. T-test result shown that both adventure and action game have higher t value (7.02 and 4.29 respectively) .This supports a significant difference. The second prerequisite is P-value need to be less than 0.05. Both games have a p-value smaller than 0.05 (adventure games have a p value .000000374069 while action games have a p value .0002736314481214). This supports a significant difference. The last prerequisite is that the 95% confidence interval of difference does not go past the value 0. Both games have a lower limit and upper limit at positive value, this means they do not go past 0. This supports a significant difference. From the three prerequisites fulfilled, it can be concluded that there is a significant difference between the cybersickness that participant perceived when using first-person perspective and third-person perspective in both action games and adventure games.

CONCLUSION

The development of virtual reality games in this study was shown as a medium to trigger cybersickness symptoms and was successful in getting cybersickness symptoms. The comparison of first-person perspective and third-person perspective was assessed by comparing the symptoms of VRSQ from the use of action and adventure games. The analysis used to determine the comparison of the increase was carried out by conducting a difference test using the paired dependent t-test statistical test. From the analysis that has been done, it is found that there is a significant difference between the use of a first-person perspective and a third-person perspective on action and adventure games on the symptoms of cybersickness that is obtained. This was proven by the acquisition of the results of the t value analysis which is greater than the critical value required at df 23. At df 23 the critical value that needs to be achieved is 2.069 while in action games the t value gets 4.29 and in adventure games the t value gets 7.02 which indicates that there is a significantly difference.

For further research, it is recommended to use more participants, this study only use the minimum amount of participant because of the global pandemic. VRSQ is very suitable to measure cybersickness symptoms. Increasing exposure time could intensify the symptoms, this study only uses 5-10 minutes exposure since it is commonly used in other cybersickness studies.

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