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Time Course of Sickness Symptoms with HMD Viewing of 360-degree Videos

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Abstract. *Previous research has shown that head-mounted display users experience sickness symptoms. However, many studies have used contents with fast motion, which might mask more subtle effects caused by the head-mounted display properties, like optical design or head tracking. To investigate the symptoms caused by reasons other than fast motion in contents, we used 360-degree videos without fast motion components. In a between-subjects experiment, the participants viewed 360-degree videos for 5, 10, or 20 minutes with Samsung Gear head-mounted display. The Simulator Sickness Questionnaire (SSQ) results indicate that symptom levels started to rise between 10 and 20 minutes' viewing time. The symptom profiles showed that disorientation symptoms dominated, followed by oculomotor and nausea symptoms. Cluster analysis revealed the presence of a high symptom group and a low symptom group in participants. In the former, the symptom levels increased with viewing time, while in the latter the symptoms remained mild. Based on the results, we can conclude that viewing time between 10 and 20 minutes is critical for the development of sickness symptoms for sensitive users.*
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1. INTRODUCTION

Increasing the size of the display screen creates a more life-like experience. For example, it has been shown that a larger screen increases the experience of presence [1–3] and produces more intensive emotional responses [4]. Because of the experiential benefits, larger screen sizes have often been a goal of technical development during the history of film [5, 6]. The widest screens surround the viewer, immersing the viewer completely. The first such system, the Cinéorama, was presented at the 1900 World Exposition in Paris. It was based on 10 synchronous projectors that projected moving images to the walls of a circular space [7]. The Cinéorama operated for only three days, but later successful systems, such as the Circarama, have been installed mostly at theme parks [8].

With increasing computer power, 360-degree videos were introduced in the 1990s, [9, 10] but until recently the technology has not been sufficiently mature for widespread use. Today, low-cost 360-degree video capturing and viewing devices are available, and immersive videos have become common. Developments especially in low-cost head-mounted displays (HMDs) have made 360-degree videos possible for all. In a recent interview, an Oculus representative stated that 80% of Gear VR users had watched videos with the device. Furthermore, seven of the top applications on Gear VR are video applications [11].

While larger display has a positive effect on the viewer experience, the possibility of negative experiences, such as sickness symptoms, increases [2, 12]. In head-mounted displays, the sickness symptoms problem has long been known [13, 14]. The symptom clusters are called cybersickness [15] or simulator sickness, [16] and are similar to the motion sickness that people experience in provocative environments like ships, airplanes, or cars [17, 18].

With adverse symptoms, virtual reality use is less enjoyable, hindering acceptance of the technology. According to Lawson, [18] 61–80% of HMD or virtual environment users experience sickness symptoms. The prevalence of symptoms is fairly high, and thus, minimizing the symptoms is an important issue in human factors of head-mounted displays.

Previous research has shown that movie watching with HMDs can be a relatively mild stimulus. For example, in the study of Häkkinen et al. [19] the nausea and disorientation symptoms were comparable when a movie was watched from television or HMD. Similarly, Pölönen & Häkkinen [20] showed that 40 minutes of movie watching caused less symptoms than game playing or text reading. However, Pölönen et al. [21] also showed that the 40-minute movie watching induced more symptoms than a similar watching from a television screen.

These early studies were conducted with head-mounted displays without tracking capability, which means that the view moved in conjunction with head movements. Many current head-mounted displays have tracking capability, allowing users to look around while the view remains stationary. Recent studies of sickness with 360-degree videos have shown that there are no differences between HMD, television, and CAVE-like display, [22] stabilized videos induce less symptoms than non-stabilized videos, [23] there are no significant differences between 2D and 3D 360-degree videos, [24] and 360-degree videos with less fast motion

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contents produce less symptoms than videos with fast motion [14].

One important aspect of sickness symptoms is the time course of the symptoms. Previous studies indicate that the symptoms increase with longer usage time [25–31]. For example, Stanney et al. [30] conducted a large between-subjects study in which they showed that sickness symptoms increase steadily between 15 and 60 minutes of usage time. Howarth and Finch [32] reported that experienced nausea increased as a function of use from 1 to 20 minutes. Similarly, Moss & Muth [33] conducted an experiment with various display delays and levels of peripheral vision occlusion. Their results showed that Simulator Sickness Questionnaire (SSQ) total scores increased significantly when participants performed five sequential 2-minute tasks in virtual reality.

Previous studies investigating the time course of sickness symptoms have not used 360-degree video contents. Thus, we aimed to determine how viewing time affects symptom levels in this modality. We also analyzed the data for individual differences in symptoms, as it has been suggested that age, gender, or past history of motion sickness would predict the severity of symptoms [34–36].

1.1 *Present Study*

1.1.1 *Short-Viewing Time*

Most of the previous studies measuring symptoms have used time periods longer than 15 minutes. However, there is a clear case to be made for shorter virtual reality use times, as currently most of the videos are fairly short, approximately 5–10 minutes [22]. Thus, elucidating how sickness is affected with shorter viewing times would be informative.

1.2 *No Fast Movements*

One should be careful when attributing symptoms to head-mounted displays in general. It is not necessarily the device, but the interaction between the device and the contents that causes the symptoms. For example, in the study of Häkkinen et al. [37] the participants used the same head-mounted display for movie watching and game playing. The fast motion of the game caused more symptoms than the slow-moving film.

As visual motion is a known significant cause of sickness symptoms, [28, 38–42] it is a variable that should be controlled. In an experimental setting, the fast motion might mask other, more subtle effects. For example, there may be symptoms caused by HMD optical design or head tracking. To identify these, we used videos made with a stationary camera and without fast movements.

1.3 *Between-subjects Design*

Many studies have used within-subjects design, as it reduces individual differences in the susceptibility to sickness symptoms. However, filling in a questionnaire repeatedly may cause changes in the self-evaluation of symptoms. Similarly, repeated exposure to virtual reality may cause adaptation that alters the symptoms. Although the latter effect may be controlled by counterbalancing the exposures, the adaptation still increases the variation in the data. Because of these concerns, we used between-subjects design.

1.4 *The Current Experiment*

We took all of the aforementioned concerns into account and performed a between-subjects study of the effect of short viewing of 360-degree videos on the magnitude of sickness symptoms. Our hypothesis was that there would be a mild increase in the sickness symptoms as a function of viewing time. However, we also assumed that the symptom levels would be rather low because of the stationary stimuli.

2. METHODS

2.1 *Participants*

Altogether 104 participants participated in the test. Twelve participants were excluded for various reasons. One participant did not pass the stereo acuity test, six participants reported problems in wearing the HMD or viewing the materials, and the visual measures or viewing times of five participants were not correctly recorded.

Thus, 92 participants were included in the final analysis. The mean age of the participants was 23.91 years (SD = 2.87), and age range was from 23 years to 29 years. Of the participants, 47 were males and 45 females. The participants were reimbursed with movie tickets.

The participants were recruited from University of Helsinki mailing lists. They came from diverse study areas, being from 21 different fields, most commonly humanities (15.2%), psychology (14.1%), and environmental science (10.9%).

Of participants, 42.3% had previous experience with HMDs and 74.8% expressed moderate or high pre-experimental interest in using HMD at work or leisure. Furthermore, 45.7% of participants belonged to the early majority group and 50.0% to the early adopters group according to the diffusion of innovations classification [43].

2.2 *Devices*

We used Samsung Gear VR and Samsung Galaxy Edge 7 mobile phone as the viewing device. The phone has a resolution of 1440 × 2560 pixels.

2.3 *Measures*

Visual acuity was tested with a Lea Numbers 13-Line Translucent Distance Chart from a 3-meter viewing distance (Good-Lite Company, Elgin, IL, USA) that was attached to an illuminated cabinet. The result is given as visual acuity, ranging between 0.16 and 2.50. Stereoscopic acuity was tested with TNO test for stereoscopic vision (Laméris Ootech B.V., The Netherlands). We used plates V, VI, and VII in the testing. Sickness symptoms were measured with the Simulator Sickness Questionnaire (SSQ), [44] which is 16-item questionnaire used for evaluating sickness symptoms related to virtual reality. There is a four-point rating scale ranging from none (0) to severe (3). SSQ produces four scores: total score, nausea score, oculomotor score, and disorientation score. The Visual Symptom Questionnaire

(VSQ) is a questionnaire adapted from Howarth et al. [45, 46]. It consists of nine items focusing on visual symptoms (tired eyes, sore eyes, irritated eyes, watering or runny eyes, dry eyes, hot or burning eyes, blurred vision, double vision, and general visual discomfort). There is a four-point rating scale ranging from none (0) to severe (3). Presence was measured with Igroup presence questionnaire [47], which is a 14-item questionnaire measuring spatial presence, involvement, and experienced realism.

2.4 *Stimuli*

We created four video compilations from the videos available in the web. Based on the expert evaluation of the authors, we selected videos without fast camera movements or other fast motion components. The length of each combination was approximately 5 minutes, ranging from 4 minutes 54 seconds to 5 minutes 8 seconds. The details of the video combinations are provided in the Appendix.

2.5 *Procedure*

In the email recruiting, we stated that participants who are pregnant or who suffer from neurological illness should not participate in the experiment. The experiments started between 9:00 am and 4:00 pm. When entering the experimental setting, the participants signed an informed consent, which clearly indicated that they can discontinue the experiment at any time. We also asked whether the participant felt normal and was not ill. We gave several examples of atypical conditions: flu, stomach illness, other illness, exceptionally severe tiredness, exceptionally severe stress, severe allergic reaction, or hangover. If participants indicated not feeling normal, they could leave the experiment without specifying a reason and still get the experiment reimbursement.

Participants' visual acuity (Lea Numbers Test) and stereoscopic acuity (TNO Test) were evaluated. The participant was excluded if visual acuity of the left or right eye was below 0.50 or if stereoscopic acuity was below 60 arc seconds.

The experiment started with the introduction of the experimental setup. The participant was told that he/she would be watching videos with the Samsung Gear device and afterward there would be a questionnaire asking about experiences during the watching session. The participant was informed that the chair could be rotated if the participant wanted to turn around to inspect the video more widely.

The participant was shown how the focus of the image could be changed with the focus wheel and was told to wear glasses. At this point, a timer measuring the usage time was started. The velcros of the Samsung Gear were adjusted until the participant indicated that the HMD felt comfortable.

The participant was instructed on how the experiment images would be shown. The participant first saw a text that was used to tune the focus. The participant rolled the focus at the top of the HMD until the image was sufficiently sharp. We measured the focus setting by using the ventilation slits at the side of the HMD (Figure 1). The slits were photographed and the focus was estimated based on the position of the slits. This method is based on the fact that the focus roll changes

Figure 1. We photographed the ventilation slits indicated by the red arrow.

the distance of the display from the eyes, which is reflected in the position of the side slits.

The participant was instructed to wear the headphone. Until this point, the HMD display was mirrored in a laptop with MirrorOp (www.mirrorop.com) so that the experiment leader could more easily instruct the participant. The mirroring ceased when the experiment started to avoid any interference with the video presentation.

In the experiment, participants watched video compilations for either 5, 10, or 20 minutes depending on the experimental group. There were 30 participants in the 5-minute group and 31 participants in both the 10-minute and 20-minute groups.

In the 5-minute group, the participants saw one of the 5-minute video compilations. The video compilation was selected so that all four 5-minute video compilations were equally shown. In the 10-minute condition, the participants saw two of the 5-minute video compilations. The two video compilations were selected so that all video compilations were equally shown. The order of the video compilations was changed so that all order combinations were shown. In the 20-minute condition, the participants saw four 5-minute video compilations. In this case, all participants saw all four video compilations. The order of the compilations was systematically changed with each participant.

3. RESULTS

3.1 *SSQ Scores*

Figure 2a shows the SSQ/Total scores in the experiments. In the 5-minute and 10-minute conditions, the score remains stable, but in the 20-minute condition the score is higher. A Kruskal–Wallis test indicated a significant effect of experimental group on SSQ/Total score ($\chi 2(2) = 6.40$, $p < 0.01$). A planned comparison with Bonferroni multiple comparisons test revealed a significant difference between the 10-minute and 20-minute groups ($p < 0.05$).

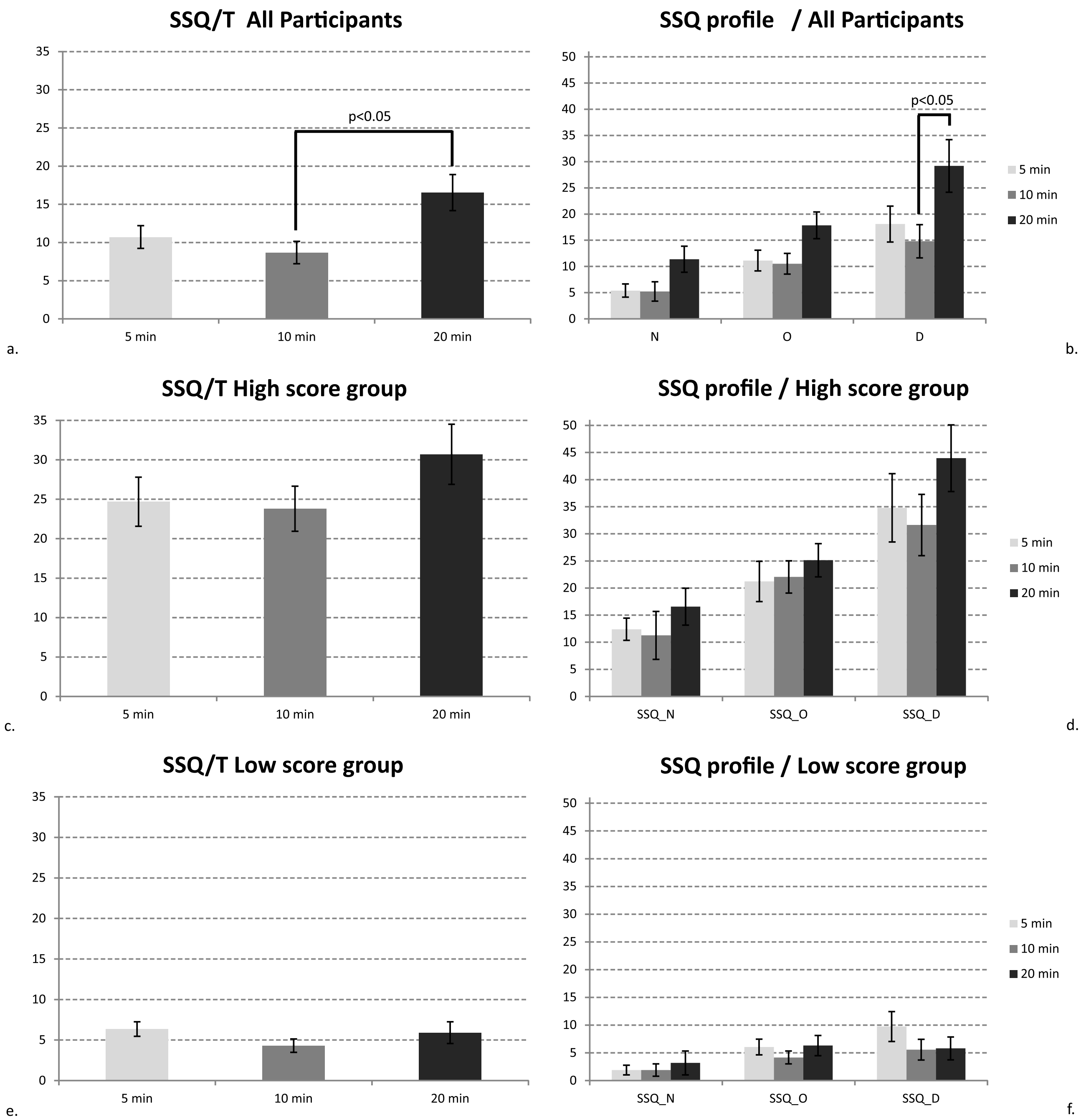

Figure 2. SSQ scores in the three experimental groups (5 minutes, 10 minutes, and 20 minutes). The error bars indicate the standard error of mean. (a) Total scores. (b) Nausea, oculomotor, and disorientation scores. (c) SSQ Total score in high symptom group. (d) SSQ nausea, oculomotor, and disorientation scores in high symptom group. (e) SSQ Total score in low symptom group. (f) SSQ nausea, oculomotor, and disorientation scores in low symptom group.

Fig. 2b shows the SSQ/Nausea, Oculomotor, and Disorientation scores in experimental groups. The total effect of experiment time on SSQ/Oculomotor score was significant (one-way ANOVA $F(2, 89) = 3.361$; $p < 0.05$). Furthermore, planned comparisons with Bonferroni multiple comparisons test indicated that the SSQ Disorientation scores were significantly different between the 10-minute and 20-minute conditions ($p < 0.05$).

To clarify the role of individual differences, we divided the participants into high symptom and low symptom groups. The SSQ/Total score was normalized and analyzed by cluster analysis (Ward's method) for the division. We conducted hierarchical cluster analysis with R software. We used Euclidean distance similarity measure and Ward's method. The grouping was based on visual inspection of the dendrogram, which showed a clear division into two

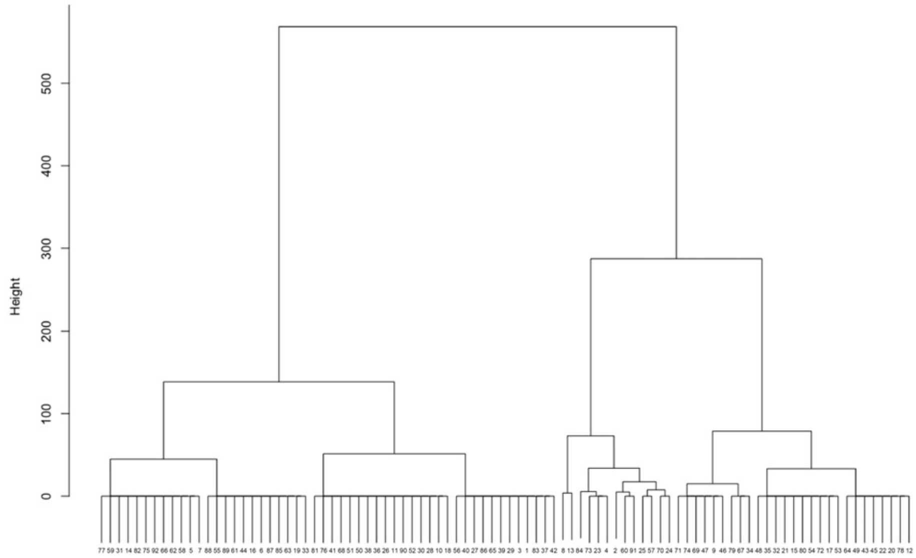

Figure 3. Dendrogram from the cluster analysis.

Table I. Frequency of participants in low and high symptom groups.

Group	Low symptom group	High symptom group	Total participants
5 minutes	18	12	30
10 minutes	20	11	31
20 minutes	12	19	31
	50	42	92

groups (Figure 3). The number of participants in each group is provided in Table I. The table shows that the low symptom group had 60.0–64.5% of participants in the 5-minute and 10-minute conditions, but only 38.7% of participants in the 20-minute condition.

The mean symptom scores for high and low score groups are in Fig. 2c–f. Fig. 2c shows that the SSQ/Total score in the high score group is high for all experimental situations. On the other hand, the SSQ profile in Fig. 2d shows a steady increase in symptoms as a function of time.

The low score group results in Fig. 2e–f show a low symptom level for all experimental situations. Statistical testing indicated that the Nausea, Oculomotor, and Disorientation scores between the high and low groups were statistically different (t-test, $p < 0.05$).

To further analyze the large individual differences, we plotted the individual scores in Figure 4. The SSQ scores of individual participants have been ordered from low values to high values to indicate the typical scores in the experiment. Fig. 4 shows that there was a large subgroup of participants who reported either none or slight symptoms in the 5-minute or 10-minute conditions.

Table II. Proportions (%) of participants showing no symptoms.

	5-minute group	10-minute group	20-minute group
No nausea symptoms	56.7%	71.0%	45.2%
No oculomotor symptoms	30.0%	35.5%	16.1%
No disorientation symptoms	33.3%	45.2%	22.6%

Table II presents the proportions of participants reporting no symptoms. The table shows that in the 5-minute condition of the experiment 30.0–56.7% of participants reported no symptoms, and in the 10-minute condition the corresponding proportion was 35.5–71.0%. Only in the 20-minute condition is the number of no-symptom participants reduced.

3.2 *Other Scores*

There were no significant differences in experimental groups in IPQ or VSQ scores.

3.3 *Focus Adjustment*

The focal distance is 40 mm and the distance from lenses to display varies between 25 mm and 35 mm. The corresponding diopter values are 2.53D and 1.51D. The position of the slits was photographed and the image pixels in the relevant area were converted to millimeters. Based on these measurements, we found that the focus value range was 1.51D–2.14D, with a mean value of 1.64D (SD = 0.11). The mean value indicates that on average participants tended to adjust the focus to a value that was near the minimum possible diopter value. We compared the focus values of

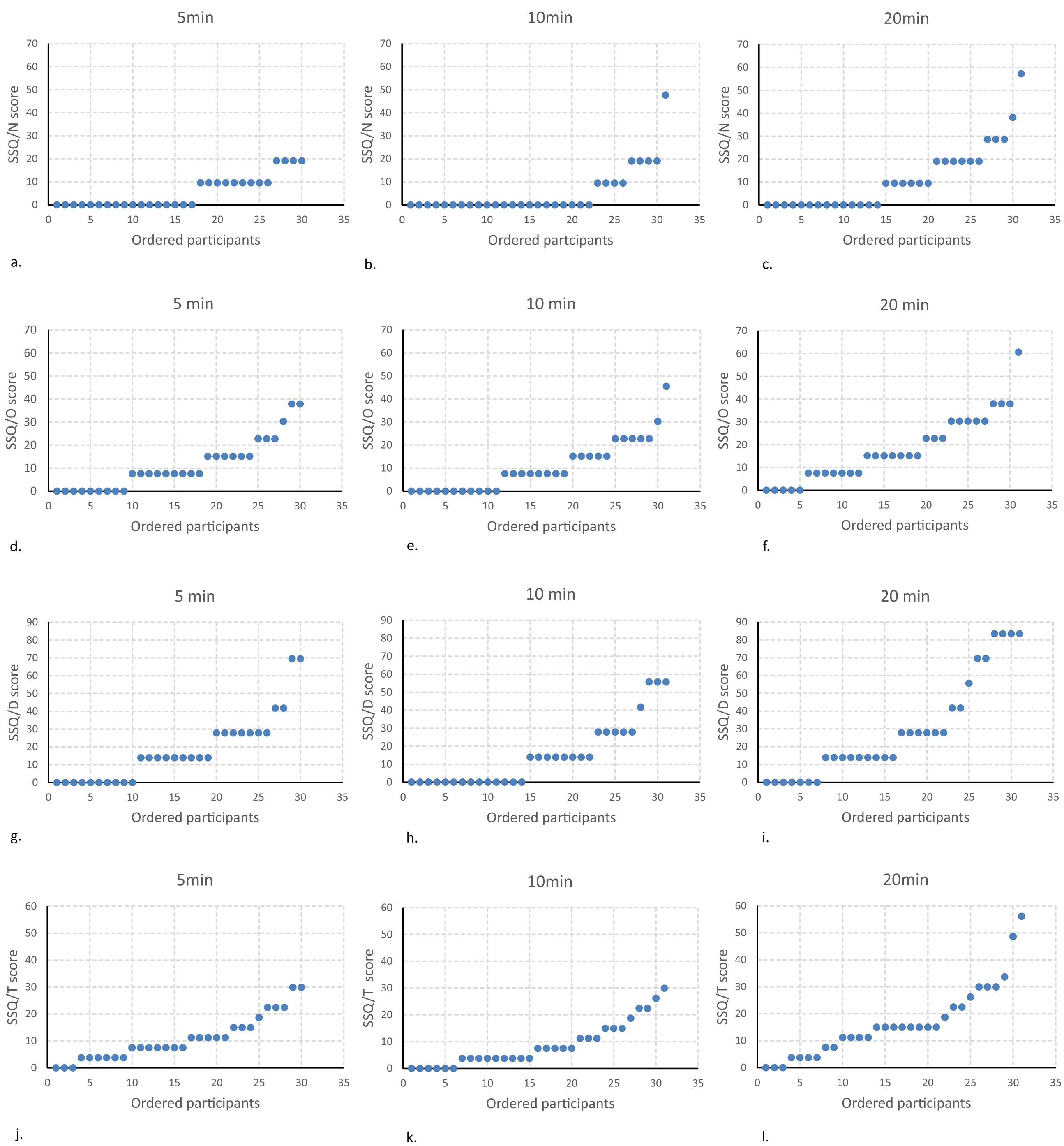

Figure 4. Ordered SSQ scores for individual participants in the three experimental groups (5 minutes, 10 minutes, and 20 minutes). (a)–(c) Nausea scores. (d)–(f) Oculomotor scores. (g)–(i) Disorientation scores, (j)–(l) Total scores.

low and high symptom groups and found no statistical differences.

4. DISCUSSION

The results indicate that watching 360-degree videos without fast movements caused symptoms for the participants. In the 5-minute and 10-minute conditions, the symptom magnitudes were smaller, while in the 20-minute condition particularly the disorientation symptoms were elevated. As the contents were selected to induce as little symptoms as possible, the increase in symptom levels may be attributed to other factors related to the viewing device and situation. These could be related to the optical properties or tracking properties of the device.

Figure 5. Mean SSQ scores in various studies.

The results resemble earlier findings shown in Figure 5. The three first bars indicate the 5-minute, 10-minute, and 20-minute groups of the current study. The next two bars are from the study of Bessa [24], where the participants watched six 360-degree videos in randomized order. We used their data from two contents and averaged the results over devices and resolutions. The first content was slow and resembled the contents used in our experiment. Fig. 5 shows that the SSQ/Total value is similar to our short-viewing time condition. On the other hand, a 360-degree video with fast motion (rollercoaster) induced much higher symptoms. Statistical testing indicated that the fast condition was significantly different from the 10-minute condition of our experiment ($p < 0.05$).

The next two bars in Fig. 5 show SSQ/Total values from studies with head-mounted display without head tracking or the possibility for a 360-degree video. In Pölönen et al. [20] and Häkkinen et al. [19] study participants watched a movie for 40 minutes. Visual comparison of the results suggests that the 5-minute or 10-minute viewing of the 360-degree contents resemble the sickness symptoms produced by the 40-minute movie watching without tracking. As the viewing time with 360-degree videos was shorter, the comparison suggests that tracked 360-degree videos induce more sickness symptoms than earlier non-tracking head-mounted displays.

The significance of the SSQ scores is an important question when interpreting the results. According to Stanney et al., [13] a score below 5 indicates negligible symptoms, 5–10 minimal symptoms, 10–15 significant symptoms, 15–20 worrisome symptoms, and a score above 20 a poor simulator. Furthermore, they state that users who score symptoms higher than 15 would not continue using the simulator voluntarily. Using this categorization, our 5-minute group is in the significant symptoms category, the 10-minute group in the minimal symptoms category, and the 20-minute group in the worrisome symptoms category.

Comparing the results with earlier data indicates that the interpretation may be more complicated. The two rightmost bars in Fig. 5 represent SSQ/Total scores that were obtained with participants playing a game with a 17 inch tabletop display [37]. The bar labeled “Häkkinen (2006) slow” includes participants playing a static game without fast movements for 40 minutes. According to SSQ/Total categorization, this would be the “significant symptoms” category. The bar labeled “Häkkinen (2006) fast” includes participants playing a fast car racing game with the same 17 inch display. In this case, the symptom levels reach “bad simulator” levels. These comparisons indicate that even ordinary display technologies produce symptoms. There are other findings that indicate high SSQ scores with tabletop displays. For example, Vinson et al. [48] showed that virtual reality with desktop display produced high SSQ symptoms after 16 minutes of use.

If the current results are viewed in the context of other results, we can say that 10-minute watching of a 360-degree video produces less symptoms than playing a static car game with tabletop display for 40 minutes. Increasing the 360-degree video watching time to 20 minutes produces symptoms that are less severe than those produced by 40 minutes of playing a fast car game with tabletop display.

The comparisons suggest that the original categorization of SSQ/Total scores might not be completely applicable in a consumer product context. The same was noted by Stanney et al. [13] who reported that the virtual environment SSQ/Total scores are typically three times higher than the data obtained from simulators. They speculate that one reason for the discrepancy might be that the original SSQ/Total scores were obtained with male military aviators,

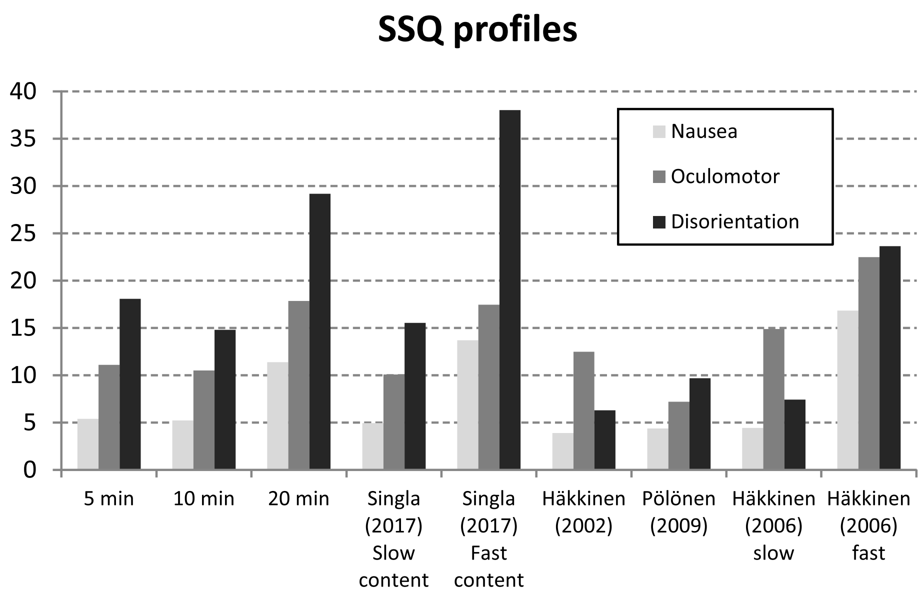

Figure 6. Mean SSQ profile scores in various studies.

who might be less susceptible to sickness symptoms than the general population. They also argue that head-mounted displays are vastly different from simulator environments.

4.1 *SSQ Profiles*

Figure 6 shows the SSQ profiles for the same studies as in Fig. 4. In head-tracked 360-degree video studies, the symptom profiles are similar, with dominating disorientation symptoms ($D > O > N$). Although the nausea symptoms are relatively milder than the other symptom clusters, they start to increase in the 20-minute condition. The increase is not, however, statistically significant.

The largest differences are in the disorientation symptoms, which were high in all 360-degree video conditions. The 360-degree videos with fast motion produce especially high disorientation symptoms. We compared our results with Singla et al. [14] and found that Singla's fast motion condition produced significantly ($p < 0.05$) more disorientation than our 5-minute and 10-minute conditions. On the other hand, even with our stationary contents, the disorientation increased, and the 20-minute condition was significantly different from the shorter viewing periods. The dominance of the disorientation symptoms is consistent with the results of Stanney et al. [30] who conducted a large study of sickness symptoms in virtual reality. It seems that some component of the head-tracked 360-degree video produces disorientation symptoms that increase quickly as a function of the viewing time.

4.2 *Individual Differences*

Based on cluster analysis, we were able to distinguish low and high symptom groups. In the 5-minute and 10-minute conditions, the low symptom group had 18 and 20 participants, respectively. In the 20-minute condition, the low symptom group had 12 participants. Interestingly, in the low symptom group the symptom levels did not increase much in any of the conditions. By contrast, the high symptom group showed a steady increase in symptom levels. Much of the average increase in the results can apparently be attributed to the high symptom group. We failed to identify any background factors that would predict the symptom levels. Further research is warranted to determine the causes of these differences.

4.3 *General Conclusions*

When users view slow and stationary 360-degree videos with head-mounted display, the symptom levels start to increase between 10 minutes and 20 minutes of viewing time. This happens even when the contents are not sickness inducing. However, a viewing time below 10 minutes appears to be comfortable for even the most sensitive users.

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APPENDIX

Videos in a single video compilation were presented always in the same order. Some videos were slightly modified for length. Also, in some cases logos or text were omitted or replaced with black screen so that the switch to the next video in the compilation would not be too abrupt. Some videos already had this effect, thus needing no modification. The modifications are indicated in the video compilation Tables A.1–A.4.

Table A.1. Video compilation 1: 5 minutes 0 seconds.

Description	Link	Length	Modification
Fixation cross		5 sec	
A 360 Look at Seahawks Pregame	https://www.youtube.com/watch?v=_fWOh14aMQc	1 min 36 sec	No modifications
Fixation cross		5 sec	
Visão 360° do alto do Cristo	https://www.youtube.com/watch?v=54ijxUufmPI	1 min 34 sec	1 sec removed from start. 5 first seconds black screen
Fixation cross		5 sec	
Cody Simpson with Coast House	https://www.youtube.com/watch?v=inSJ4VMaYRs	1 min 30 sec	3 sec removed from the start and 4 sec from the end. 3 first seconds and 3 last seconds black screen
Fixation cross		5 sec	

Table A.2. Video compilation 2: 4 minutes 54 seconds.

Description	Link	Length	Modification
Fixation cross		5 sec	
Volley Interactive 360	https://www.youtube.com/watch?v=PlYj_yccdTY	37 sec	4 sec removed from the beginning and 7 sec from the end. Black screen 2 sec at the start and 5 sec at the end
Fixation cross		5 sec	
A Szabadság Hidja Piknik a lezárt Szabadság hídon	https://www.youtube.com/watch?v=gasdvLkYmjU	1 min 2 sec	
Fixation cross		5 sec	
Opening Dance—Dancing with the stars (360 video)	https://www.youtube.com/watch?v=vEk2poiXSFU	1 min 12 sec	3 sec removed from the end. 4 sec black screen at the end
Fixation cross		5 sec	
A 360° journey to Africa: Lonely Planet—The Travel Book	http://www.dailymotion.com/video/x4x2x9i_a-360-journey-to-africa-lonely-planet-the-travel-book_travel	1 min 38 sec	Black screen 4 sec at the beginning and 4 sec at the end
Fixation cross		5 sec	

Table A.3. Video compilation 3: 5 minutes 8 seconds.

Description	Link	Length	Modification
Fixation cross		5 sec	
The Eye Of The Tiger 360°	https://www.youtube.com/watch?v=xaI78egELos	1 min 38 sec	Black screen 5 sec at the beginning and 5 sec at the end
Fixation cross		5 sec	
360 On-the-scene at #TOMMYNOW pier	https://www.youtube.com/watch?v=Nks7HST_of0	56 sec	3 sec removed from the end. Black screen for 1 sec at the end
Fixation cross		5 sec	
A 360° Look Into snow-covered Franklin, Tennessee	https://www.youtube.com/watch?v=BBrI-ucKKsI	2 min 14 sec	
Fixation cross		5 sec	

Table A.4. Video compilation 4: 4 minutes 54 seconds.

Description	Link	Length	Modification
Fixation cross		5 sec	
360 On-set w/ Hailey Baldwin & Lucky Blue Smith	https://www.youtube.com/watch?v=iLd8K_u1flk	1 min 3 sec	1 sec removed from the end. Last 5 sec black screen.
Fixation cross		5 sec	
Samsung School of rugby — 360 video	https://www.youtube.com/watch?v=fCTwcs_ZrhM	1 min 17 sec	1 sec removed from the end. Last 5 sec black screen
Fixation cross		5 sec	
Final Frontier 360: A STAR TREK THEME in 360°	https://www.youtube.com/watch?v=HfR6p0aN5f0	2 min 14 sec	4 sec removed from the beginning and 8 sec from the end
Fixation cross		5 sec	

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