

Treating Presence as a Noun—Insights Obtained from Comparing a VE and a 360° Video

M Tarnawski[†]

Södertörn University, Sweden
martina01.tarnawski@student.sh.se

Abstract

With 360° videos becoming more commercially available, more research is needed in order to evaluate how they are perceived by users. In this study we compare a low-budget computer-generated virtual environment to a low-budget 360° video viewed in VR mode. The Igroup Presence Questionnaire (IPQ), discomfort-scores and semi-structured interviews were used to investigate differences and similarities between the two environments. The most fruitful results were obtained from the interviews. The interviews highlight problematic aspects with presence, such as the difficulty of separating reality, real and realistic, which leads to a reconsideration of treating presence as a concept. The conclusions are that VR research should benefit from treating presence as a noun, the feeling of “being there” instead of a unitary concept. We also argue that presence should not by default be considered a goal of a VR experience or VR research.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual reality

1. Introduction

Even though presence has been evaluated and researched upon in numerous studies [LD97, FAM*00, IFR00, WHB*07], there are still many uncertainties surrounding the topic. For instance, we need to find an agreed definition of presence [TMTC03] in order to clarify what exactly is measured and thus figure out *if, why and how* it needs to be measured. Even though no agreed definition of presence has been set, research in the area of VR has almost reached an obsession of trying to achieve presence. The most basic question seem to have been lost along the way, namely “*Is presence the main goal of VR?*”. With new technologies available today such as 360° videos being viewed in VR mode, the determinants and definitions of presence seem to be even more confusing and perhaps misleading. The aim of the study was to compare a low-budget computer-generated virtual environment to a low-budget 360° video recorded from the real world, both including an acrophobic scenario, with focus on presence and discomfort. The use of presence and problematic aspects of the term was shown to be an interesting subject to examine. The current paper thus aims at investigating if presence always is a goal for VR, and if so, how presence can

be measured across media in a way that makes the results comparable to other studies.

Dalvandi et al. [DRC11] claimed in 2011 that little research regarding level of presence in panoramic videos has been done, and it seems that is still the case. 360° videos are omnidirectional, thus allowing the user to look around in the videos which could make the experience highly immersive [RC13]. Immersion can have an impact on presence [BBA*04]. Thus, 360° videos have great potential of inducing presence. However, since presence often is discussed in relation to VR including computer-generated virtual environments (VEs), and that the existing studies targeting presence for 360° videos often include expensive material [DRC11, RC13], we need to examine whether the term and current measurements are appropriate when evaluating low-budget 360° videos.

2. Presence

There are various definitions of the term presence: “*as though they are physically immersed in the virtual environment*” [GT07, p. 343], “*the sense of being inside the virtual environment*” [AJGMRG11, p. 504], “*being there*” [IFR00, SUS95]. Lombard & Ditton [LD97] examined presence by describing six conceptualisations included in the concept of presence. According to them, the main idea of

[†] Masters student

presence is the *perceptual illusion of nonmediation* that refers to when a user responds as if no medium were there, that the user does not acknowledge that a medium is used.

Wirth et al. [WHB*07] constructed a theoretical model for the formation of *spatial presence* and argue that a model of spatial presence is the only solution to make sure that research in presence progresses. The authors claim that two critical steps are required in order to experience spatial presence. 1. The user needs to create a mental model of the situation, a *Spatial situation model* (SSM). 2. From this SSM, spatial presence can occur if the second level also is achieved, which is called the *medium-as-PERF-hypothesis* and refers to the user accepting the mediated environment as primary egocentric reference frame (PERF). If these two steps are achieved, it means that the users have positioned themselves in the environment and perceived the possible actions. The model includes other factors that affect the critical steps, including for instance attention allocation, higher cognitive involvement and suspension of disbelief, the users' willingness of ignoring distractions that could affect their possible wish of entertainment, such as inconsistencies.

In addition, there are various approaches that can be taken in order to measure presence, and the most common method is post-test questionnaires and rating scales [IFR00], such as the presence questionnaire (PQ) [WS98] and the Igroup Presence Questionnaire (IPQ) [SFR01]. There are clear advantages to using these types of questionnaires such as them being easy to administer and not disrupting the user's experience. However, the questionnaires are reported after the experience, which means that aspects such as variations of the level of presence during sessions cannot be detected [Ins03]. Other post-test methods targeting presence include pictorial scales [WSPW15], interviews [MAT00] and a memory test [LDAR*02].

Dalvandi et al. [DRC11] evaluated level of presence comparing VEs created using different methods of including images and videos captured from a real environment. In order to measure presence, a 6-item questionnaire including items from different sub-scales of the IPQ was used. The VE including the panoramic video was proven to be the most expensive and time-consuming to produce among the three, however it was also the one shown to induce the highest level of presence.

There are also methods that can be used during session to measure presence such as the *Continuous presence assessment* which includes a hand-held slider [IFR00], and concurrent verbal reports [TMTC03]. However, these techniques can interrupt the user's experience [IFR00, TMTC03]. Objective measurements such as postural responses [FAM*00] or physiological measures [Ins03] are also alternatives for measuring presence.

3. Methods and Material

3.1. VE and 360° video

The recorded environment simulates the experience of being located on the top of a ladder leaned against a rooftop. A similar environment was created as a computer-generated virtual environment, VE. The sound recorded in the video was also used for the VE. Both environments only allowed the action of looking around. Figures 1 and 2 show screenshots of the environments.

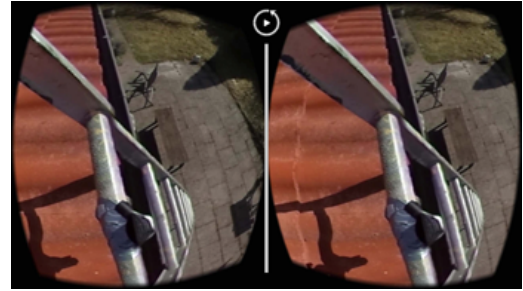


Figure 1: Screenshot of the 360° video used in the study.

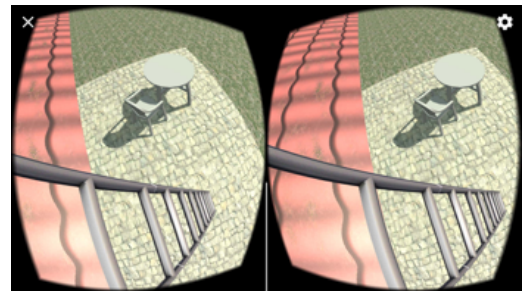


Figure 2: Screenshot of the VE used in the study.

3.2. Measures

Juan & Perez [JP10] compared the level of presence and anxiety in a VE and an augmented reality environment. The participants were asked to rate their level of anxiety on a 10-point scale 6 times during each experience. In this study, a similar approach is taken and the participants have reported *discomfort-scores* during the session. However, the scores have only been reported 3 times during each experience since the participants only experienced each environment for approximately 1:30 minutes. By using the term *discomfort*, the scale becomes similar to methods used in previous studies [CSSS06, KDSCH12, WBBL*15].

In order to measure the participants' perceived level of presence in the 360° video and the VE, the Igroup presence questionnaire (IPQ) was used. The IPQ contains 14 items that are answered on a 7-point scale. The items are divided in: General presence (G), Spatial presence (SP), the sense of being physically present in the environment,

Involvement (INV), the experienced involvement and attention directed to the environment, and Experienced realism (REAL), the subjective experience of realism in the environment [Igr16]. In order to facilitate for the participants in this study, the IPQ was translated from English to Swedish. The fact that the questionnaire has been translated in two steps and adapted to 360° videos must be taken into consideration if the results from this study are compared with other studies using the IPQ since these versions have not been tested. However, using adapted versions of existing questionnaires to better suit the study is common [LDAR*02, TMTCO3, JP10, DRC11, RC13].

Semi-structured interviews were also included in order to receive a deeper knowledge about the participants' answers. The questions were inspired by previous research as well as insights from the first sessions conducted where tendencies could be noticed regarding differences in behaviour and discomfort for the two environments. All answers from the interviews except those from the follow-up questions were recorded, transcribed, and analysed using a thematic method [BC06].

3.3. Apparatus

The HMD used in order to view the environments was Spectra Optics G-01 3D VR Glasses. The headphones used were Sennheiser HD 418 which have a close-back design that blocks out much noise from the outside. The smartphone used in the experiments was a Samsung Galaxy S6 and the application used to view the VE was the 360 VR Player |Videos.

3.4. Participants

Due to the lack of research regarding differences between 360° videos viewed in VR mode and VEs, this study aimed at including people with a broad age range in order to form a foundation for future studies. 21 participants were used for the quantitative part of the study. Their age had a range of 19–72, mean age 37.8 ($SD = 19.4$). 11 of the 21 participants also took part in the interview (one interview was discarded due to confusion of the environments). The participants were contacted through an art school and one workplace and remaining participants were contacted through digital channels. The participants did not receive any financial reward. The inclusion criteria for participation were that they could not wear glasses during the experiment or perceive themselves as being extremely afraid of heights.

3.5. Procedure

The sessions were conducted in a room where no other people than the researcher and the participant were present. The order in which the environments were viewed was randomized and counterbalanced resulting in 10 people starting with experiencing the VE and 11 with the 360° video.

Each session began with a brief introduction of the session. It was explained to the participants that they could end the session at any time and that simulator sickness can occur. Before the sessions begun, each participant was also asked if they are extremely afraid of heights in order to exclude people that could find the experience too frightening. The experience began with the participant facing the roof. A discomfort-score was registered (moment 1), and the participant was then asked to look and move around. The participant was also specifically asked to look down. After approximately 30 seconds a discomfort-score was marked (moment 2), and after around 80 seconds the last discomfort-score was registered (moment 3). After the first experience, the participant filled in the first IPQ. The next environment was experienced using the same procedure as the first, and yet another IPQ was filled in afterwards. For the 10 first participants, the session ended there. The remaining 11 were requested to answer a few questions and also if they approved that the interview was recorded in order for it to be analysed later. The sessions lasted for around 20 minutes.

4. Results

4.1. IPQ and Discomfort-scores

The scores from the IPQ were analysed using paired t -tests. The means for each participant's answers for the different categories for the VE was calculated and compared to the means of the 360° video, thus compiling the questions belonging to the same category. The significance level was set to 0.05 in all statistical analyses. No significant differences between the VE and the 360° video were found in the categories General presence ($p = 0.521$) and Spatial presence ($p = 0.332$). However, significant differences were found in Involvement ($p = 0.031$) and Experienced realism ($p = 0.004$) where the 360° video received higher scores. The means of the discomfort-scores for the two environments were also compared using paired t -tests. It should be noted that the participants might have reported the discomfort-scores looking in different directions, however, since the environments do not include any other actions than the possibility to look around, one could also assume that a general feeling of the environment was created fairly quickly. No significant differences were found among the results (moment 1: $p = 0.835$, moment 2: $p = 0.557$, moment 3: $p = 0.137$). Four participants reported a discomfort-score of 0 on all moments in the 360° video. Two of these four participants also indicated the same score for the VE and the other two participants indicated higher scores for the VE.

4.2. Interviews

The first interview question was inspired by a question included in a study by Juan & Perez [JP10, p. 760] that used an adapted version of a questionnaire created by Slater et al. [SUS94]: "During the experiment, did you think that you actually were in any of the environments?" Some participants directly associated the question with the factor of

realism and indicated that they felt more there in the 360° video because they found the environment more real or realistic. An expression that should be highlighted among the answers is “*felt like another reality*”. The participant felt more as if being there in the 360° video and the statement was mostly referring to that environment. What is interesting is that the participant did not say that it felt as “reality”, but as *another* reality which indicates that s/he felt present in the 360° video even though it did not feel as our reality. This view could be interesting to evaluate regarding VEs. By using the words “another reality”, the comparison of the VE to the real world that many people automatically seems to do, can be minimized. Marini et al. [MFG12] suggest that the goal of a VR experience could be to make it *believable*, rather than real, since the aim is to convey the idea that the VR experience is the real thing. They suggest that in order to achieve a believable VR, realism is not always needed and a symbolic approach can be used. When choosing the word believable, people may ask themselves “would the world look and feel like this *if* it existed?” and not “does this world look much like the existing world?”. An item that could be included when the goal of a VE is to make it believable is: “*The virtual environment/360° video felt believable*”, with anchors *Not at all–Completely believable*. Another item could be: “*The environment felt like it could exist in another reality*” with anchor points *Felt as it could not exist at all–Felt as if it definitely could exist*. The anchor points are important since some people may feel that the environment could exist in *our* reality. An item targeting this could be: “*The environment felt as if it could be a part of our real world*”, with anchors *Not at all–Definitely*.

One participant mentioned a feeling of being there in both environments, but in different ways, due to the 360° video looking more real, but also having a feeling of becoming a video game character in the VE. This person also claimed having good knowledge of video/computer games and also having tried VR earlier and finding it exciting. Due to this, it might be possible that this person had a wish to be entertained in this experience as well and it might be argued that the participant could have been more willing to overlook distractions in the VE and had a greater suspension of disbelief than others. However, this participant described the appearance of the VE in a detailed way, thus having been fully aware of inconsistencies such as standing far away from the ladder. One possibility is that the person was aware of the inconsistencies but may not have compared the experience as much with *our reality* but more to the feeling of playing a game, which might be viewed as *another reality*. The same participant made a similar comment regarding the perceived realism of the environments. The participant mentioned that the 360° video was more real since it *looked* more real, however the person said that s/he felt more static in that environment. Even though the participant stated that s/he knew that the same actions were possible in both environments, it was still perceived as if more actions were possible in the VE and it thus felt real.

From a follow-up question, the participant also explained

that the feeling of being a character in a video game lead to feeling that it should not matter if s/he was to fall down the ladder since a new life would be received as in video games, and that this made it more comforting. One participant mentioned expecting movement in the VE due to the fact that it looked much like a computer game. Another participant experienced the VE as being part of a game but found it disconcerting due to not knowing what actions that were possible in the environment. This participant also mentioned having very limited knowledge about video/computer games and no previous experience of VR. The one with greater knowledge was thus aware that most video/computer games offer a second chance when failing or “dying” while the other participant might not share the same view or consider it. The later mentioned participant did not feel as *being there* in the VE which could be due to the person comparing the experience to our reality and not the feeling of being inside a game. This could be an indication of the difficulty of separating the feeling of being there to the feeling of being in a place that exists in our reality. Previous experience of VR does however not automatically lead to a greater feeling of being in the VE. Two other interviewed participants had previous experience of VR and clearly stated feeling there to a greater extent in the 360° video. What people compare the VE experience with or how they perceive the environment thus seems to be truly personal.

A majority of the interviewees perceived the 360° video as undoubtedly more real. One person mentioned in the interview that s/he recognized the recorded area in the 360° video which may have affected the answers and made the participant perceive that environment as most realistic. The feeling that the environment exists or might exist in the real world is however different from the feeling of being present in the environment but seems to be difficult separating. For 360° videos that only include recordings of existing environments, it could be redundant measuring how aesthetically realistic people perceive the environment, and other aspects such as involvement and spatial presence may be more interesting measuring which can indicate whether people felt an interest for the environment and as if they were physically there. However, one participant mentioned that the perspective in the 360° video looked unreal, thus, questions regarding how real or realistic the environment looks could be included if the goal of the environment is to make it look as realistic as possible.

Some mentioned height as the main reason for feeling discomfort. Other participants experienced nausea or vertigo when viewing the VE but not as much in the 360° video. This might be due to latency in the head-tracking movement that only occurred in the VE, which was calculated in real-time. Confusion around the feeling of being able to look around was also a reason for discomfort. Another participant mentioned that s/he was afraid of falling down the ladder and that this made the person conscious about the amount of movement s/he initiated. The participant also mentioned a feeling of wanting to grab the ladder. The per-

son felt equally about these aspects in both environments, however the participant only mentioned trying to walk and climb up the roof in the VE that was the environment tested last.

5. Discussion

5.1. Realism

According to previous research, the feeling of presence will positively be achieved when experiencing a convincing illusion of reality [PSR13]. However, in this study it became noticeable that the term *reality* can be confused with terms such as *real* or *realistic*, particularly when translated into different languages. Item number 12 in the IPQ was confusing for some of the participants: “*The virtual world/360°-video felt more realistic than the real world.*” In the original version of the IPQ, the German word used for *realistic* is *wirklich*. The German “*wirklich*” does not have an equivalent in English [Igr16]. The word “*wirklich*”, and Swedish “*verklig*” can have the meaning of existing (in the world) and that can be detected through senses. This definition is very different from the Swedish translation of the word “*realistic*” (“*realistisk*”) which can be described as being characterized by realism and seems to be used more often when describing that something looks or feels lifelike, as it does in the real world. This can however be confusing since the English word “*realistic*” can refer to when something seems to exist or be happening in fact. The word *real* could be a suitable translation of “*wirklich*”. “*Wirklich*” can however have other definitions than the one mentioned earlier, which may not match the Swedish translation of “*real*” in this context.

For the items in the original IPQ where it is asked how “*real*” the environment seemed to the participant, the German *real* was used, which in Swedish translates to “*verklig*”. However, in item 12, the Swedish translation of the word “*realistic*” was used, “*realistisk*”. The participants seemed to perceive the question differently and thought it was difficult comprehending what was asked for. One aspect that may have contributed to the confusion was the fact that one of the tested environments was a video, recorded from the real world, and it could thus seem strange asking if the environment felt more realistic than the real world. We propose that it may be beneficial to use the term *real* instead of *realistic* in contexts where the participants are asked for the overall feeling of realism in the environment and not the aesthetic appearance. The item should also be more specific in order to avoid confusion: “*During the experience, the virtual environment/360° video felt more real than the environment I was physically located in.*” However, we suggest that this question only should be used when the purpose of a study is to achieve realism.

There was no significant difference in the scores from the VE and the 360° video on item 12 in the IPQ ($p = 0.119$). This could be due to that the participants were asked if the environment *felt* more realistic, and not how it looked. The English version of the IPQ asks if the world *seemed* more

realistic than the real world which is not the term used in the IPQ in this study since the Swedish translation worked better using the equivalent of “*feel*”.

Having in mind the aspects discussed above, it is not surprising that the 360° video received higher scores in the category Experienced realism in the IPQ. No significant differences in General presence or Spatial presence were however found which could indicate that the participants in general felt that they were physically present and felt as if being there in both environments.

5.2. Defining presence

This paper suggests that presence no longer should be treated as a unitary concept and that aspects often included in previous research as a part of the concept presence should be treated separately. This is both due to the term being ambiguous but also since presence may not always be the true or only goal for VR. This study indicates that evaluating presence becomes even more problematic when comparing level of presence in 360° videos and VEs. This is mostly due to that 360° videos look realistic and people confuse the aesthetic features to the feeling of *being there*. The results also indicate that the VE affords more actions but that it may be difficult expressing this feeling. In order to further investigate this topic, we propose the following questions: “*During the experience, to what extent did you try to interact with the environment in more ways than just looking around?*”, “*Before the experience, to what extent did you believe that you were going to be able to interact with the environment you were to experience?*”, and “*To what extent did your initiated actions receive a response by the environment?*” The questions suggested above are similar to some items of the PQ [WS98]. According to Slater [Sla99], the PQ measures how users respond to the attributes of the system used rather than presence. However, we suggest that these questions do not have the aim to target presence, rather the aspects that Slater [Sla99] mentions. These questions could be used in further studies where 360° videos and VEs are compared or other studies where expectations and perceptions of affordances in VR are evaluated. Postural responses as used in the study by Freeman et al. [FAM*00] might also be an alternative for such studies but where the method is applied in order to measure expectations rather than presence.

In future studies similar to this, where realism is not the main goal, it is suggested to exclude questions that include the word “*realistic*” and perhaps even the word “*real*” in order to minimize the risk of confusion of what is actually measured. We need terms, or rather, words, that target the feeling of *being there*. The word needed could be “*presence*”, but not as *the concept* of presence, but as a *noun*, meaning the feeling of being in the environment. When asking questions about presence, perhaps no underlying framework or intricate definitions with multiple dimensions should be used due to that participants do not always share this framework [MAT00].

There were no significant differences between the results

on General presence in the IPQs in this study. The item was as follows: “In the virtual environment/360°-video I had a feeling of “being there”.” (in the original IPQ the item is taken from Slater & Usoh [SU94]). A similar question was asked in the interviews: “During the experiment, did you think that you actually were in any of the environments?” In the interviews, a majority of the participants clearly stated that this feeling was stronger in the 360° video than the VE. However, taking a closer look at these participants’ answers on the item in the IPQ that targets General presence, some interesting results were found. One of the 6 participants scored the same for both environments and another actually reported a higher score for the VE even though having mentioned feeling there to a greater extent in the 360° video in the interview. The result might be due to poor choice of words in the interview question. By asking the participants if they “thought that they actually were there” it could be possible that people are reluctant to report a higher score on the scale since it might sound as if hypnosis or psychosis was involved. Lombard & Ditton [LD97] discuss this with regard to the illusion of nonmediation and claim that this illusion does not include confusion of what is real or not or psychological defects. However, this is something that probably is obvious to most researchers but not to the participants of a study. For future research where presence is measured we suggest to try the simple question: “Did you have a feeling of ‘being there’?”

Treating presence as a noun that indicates the feeling of being in a place, rather than a term consisting of multiple aspects, we could finally complete the one mission many researchers in the area of VR are dealing with, namely trying to find an appropriate definition of presence. However, this does not mean that presence as the noun “feeling of being there” is the one and only aspect that needs to be evaluated in VR. We suggest that researchers should carefully choose aspects that are necessary to evaluate in order to achieve their goal. In video games, perhaps *involvement* is the main goal that should be strived towards. In a project where the aim is to simulate an already existing environment, such as the Eiffel tower or a botanical garden, the main goal may be that it *looks realistic* and *real*, that it looks and feels as the actual place. In a science fiction 360° movie, the main goal can perhaps be to make it *believable*. In a VR experience that includes meditation or mindfulness, *presence* could be the main goal.

To summarize, we suggest that presence is not always the main goal of a VR experience and VR research should not by default aim towards it. However, presence as the noun “feeling of being there” may in some projects be an aspect to strive towards.

5.3. Measuring presence

It is here argued that presence should not automatically be seen as the true goal for VR. However, some projects may include presence as a goal and a measurement that could be applied across media is thus needed in order to investigate

if, how and why presence should be evaluated. By treating presence as a noun, meaning the feeling of being in a place, the questions could be easier to answer and it might be easier applying the same instrument across media.

Depending on the techniques used in a VR system, questions regarding the different aspects could be examined in order to find out what needs to be improved in order to achieve the desired goal, for instance presence. Although previous studies may have evaluated how these aspects affect presence, they may not give appropriate answers since the method used in order to investigate presence may include multiple dimensions that do not align with the definition of presence used for the proposed study. For instance, Schuemie et al. [SAvdM*05] concluded that a more natural locomotion technique leads to more presence. In their study, presence is measured using the IPQ which means that the categories General presence, Spatial presence, Involvement, and Experienced realism have been included to measure presence. However, the result only refers to presence as a whole, including all aspects mentioned above which means that we do not know how the different categories influenced the result. Results from the current paper indicate that the different categories in the IPQ may benefit from being treated as separate aspects rather than combined into a concept of presence.

Applying pictorial scales [WSPW15] might be a useful way of measuring presence since no words are used that could be confusing for the participants or difficult translating. The scale measured attention allocation, spatial situation model, self-location, possible actions, cognitive involvement, and suspension of disbelief. The scale is referred to as a presence scale, indicating that all categories together can create the level of presence. A confusing aspect is that *spatial presence* and *presence* are treated as the same thing in the study since they mention that presence can be referred to as spatial presence and that spatial presence often is referred to as “being there”, which also is a common definition of presence [IFR00, WSPW15]. However in the study by Schuemie et al. [SAvdM*05], spatial presence is seen as a sub-category of presence. Weibel et al. [WSPW15] thus used other definitions, determinants and categories for measuring presence than the ones used in the study by Schuemie et al. [SAvdM*05], however, both studies claimed having measured presence, or more precisely, Weibel et al. [WSPW15] claim having measured spatial presence which they refer to as the same as presence. A pictorial presence scale such as the *Pictorial Presence SAM* might be a good alternative for measuring different aspects of a VE. However, for future work, we suggest to choose the categories of the scale relevant for the study and not treat the whole scale as a presence-indicator since all factors such as “possible actions” might not suit the system or goal used for all studies. For example, possible actions may not be a determinant if we aim at achieving presence in a 360° video that only includes the action of looking around.

The study by Dalvandi et al. [DRC11] included 360°

videos, and items from different categories of the IPQ were applied in order to measure presence. Ramalho & Chamber [RC13] also conducted a study where presence was measured using a system that included 360° videos where they used an adapted version of the PQ. Since the IPQ and the PQ include different items, the two studies have used different frameworks and approaches to presence, making it difficult knowing if the same aspect actually has been measured. As outlined in this report, there are various ways of measuring presence, often by evaluating multiple aspects of the concept but where the outcome represents all aspects as a whole, as the concept presence. Comparing results of presence where different dimensions, definitions or sub-categories of presence are used could thus be misleading and we propose that studies thus cannot fully rely on previous research of presence when concluding what is needed for achieving presence in the VE to be produced.

6. Conclusions and future work

This study had the main purpose of comparing a low-budget computer-generated VE to a low-budget 360° video viewed in VR mode. The most fruitful results were obtained from the interviews. As the project proceeded, the notion of presence turned out to be an interesting but also confusing aspect and we thus decided to investigate this deeper, concluding that the current conceptualisations and measurements of presence are problematic. Results show that the low-budget environments used in this study induced discomfort for several participants. This suggests that low-budget alternatives for VEs and 360° videos might be useful for projects where the aim is to induce fear, such as virtual reality exposure therapy.

Even though the majority of the participants mentioned that the environments looked similar, there are aspects that differentiate them. A study similar to this where more resources are applied to the creation of the environments making the environments more alike would minimize the risk of other aspects than the technique used to have an impact. However, in this study, the aim was to compare the two environments used, rather than comparing the techniques in general. The interviews highlight that discomfort can appear for different reasons and it is thus important asking more detailed questions if the goal is to target a specific aspect of discomfort. In such studies it may also be beneficial to perform pre-tests and exclude people who are more likely to experience motion sickness in order to eliminate variables that are not in focus. Since the environments in this study did not include any possible actions other than look around, there are various ways studies similar to this could be conducted. For instance, a 360° video that includes automatic movement could be compared to a VE including locomotion for the purpose of provoking fear or achieving realism.

Both the IPQ and the interviews also point out confusion around the words reality, real and realistic. We suggest choosing the word “real” in contexts where the overall feeling of realism in an environment is measured. If the aim for a

VE is not to reproduce reality, rather to reproduce realities that could exist, we propose that the word “believable” is used. This study has given clues that some people perceive more possible actions in a VE than in a 360° video. In future studies, questions around this topic could preferably be included in order to evaluate how people interact and adopt VR.

One of the most noteworthy conclusions drawn from this paper is the notion of not treating presence as a concept including complex underlying dimensions, and start treating it as the noun, the feeling of being there. In this way, an agreed definition could be set and it could be easier to measure presence across media which could be as simple as including following question: “Did you have a feeling of ‘being there’?”. We suggest that presence should not automatically be a goal for VR. However, if presence is the main goal of a VR project, it needs to be evaluated considering the techniques and goals of that specific study. Results from other studies measuring presence might not be relevant since presence may have been considered a concept including multiple aspects and it could be unclear what factors contributed to the results. We suggest that all factors and sub-scales used in current measurements (e.g. presence questionnaires and pictorial scales) should be treated separately in order to clearly state what has been measured, and when mentioning presence, it is only referred to the noun of being there without any underlying framework.

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