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THE USEFULNESS OF USING VIRTUAL REALITY TO ASSESS ELDERLY AND DEMENTIA FRIENDLY HOSPITAL DESIGN

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Abstract

Virtual reality (VR) provides unique tool to conduct leading-edge research in several areas with the overarching mandate of providing innovative solutions in a manner, which ensures connectivity and adaptability of interdisciplinary research such as, architectural and medical research to changing technologies. The Patient safety movement is creating a “culture” where the omission and commission of clinical actions are minimized. Thereby, reducing risk of harm often related to such events as medication errors and falls. With great increase in older adults’ health care expenses, assessing physical environment is becoming essential to reduce patient’s injuries during hospitalization and optimally reduce the cost of health care resulting from these injuries. This review focuses on the usefulness of using virtual reality in assessing the effect of architectural design on mental health disorders. It also suggests future directions for the use of virtual reality so it can be implemented to improve hospital physical design to mitigate injuries sustained by older patients suffering from dementia. Furthermore, major virtual reality test mediums, and the critique over using them in the assessment of architectural environments will be discussed.

Keywords: Virtual Reality, Architectural Environment, Design Assessment, Elderly Care, Dementia.

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1. Introduction

Every year many older adult patients, particularly those with dementia and other cognitive challenges, sustain further injuries during their hospital stay (Baker ao., 2004: 1678; Lawton ao., 2012: 369; Schnitker ao., 2011: 141; Thomas and Brennan, 2000: 741). These injuries cause extra strain on the healthcare system. The use of virtual reality and virtual environments to assess potential design elements in hospital facilities was proposed to limit injuries and stress sustained by older patients with cognitive impairments during their stay in the hospital (Huisman ao., 2012: 70; Parke ao., 2017: e62; Ulrich ao., 2004; Ulrich ao., 2008: 61). To improve older patient-care environment, researchers should focus on a proactive assessment of ergonomic risks resulting from the physiological and psychosocial demands placed on older patients. In this review, we will focus on the usefulness of using virtual reality in improving architectural design to better serve older people who are suffering from mental health disorders. We will also suggest future directions for the use of virtual reality so it can be implemented to improve caring facility design for older adults with dementia. An aim which was set to make hospitals safer and more reliable environments, and optimally reduce the cost of healthcare. Furthermore, major virtual reality test mediums, and the critique over using them in the assessment of architectural environments will be discussed in this review paper.

Planning, designing, and building elderly-friendly environments is an important and complex endeavor. Elderly-friendly environments must consider four dimensions: social, policies and standards, care systems, and physical design of the built environment. The elderly-friendly environment aims to maintain, promote, and enhance where possible the independent functional ability of older people. Components that are of relevance to elderly-friendly design can include lighting, color, floor coverings, wall coverings, hallways, doors, windows, handrails, way-finding signage, walkways, ramps and stairways, acoustic considerations, and other special considerations such as parking and washrooms. Designing these components appropriately to achieve an elderly-friendly environment, can optimally facilitate recovery, reduce potential injury, and reduce health care costs. However, by considering the high cost of implementing an elderly-friendly architectural design without backup by evidence-based research, made virtual reality a possible emerging tool that could be used to study the concept of elderly-friendly hospital designs before the physical implementation of those designs. Furthermore, experimenting in virtual environments is more controllable, scalable, safer and structured than experimentation done in physical environments (Adi and Roberts, 2014: 261; Anderson ao., 2003: 240; Banaei ao., 2020: 138; Heydarian ao., 2016: 212; Huang ao., 1998: 175; Parke ao., 2017: e62; Roy ao., 2003: 411).

2. Virtual Reality Test Mediums

There are many test mediums that are available in virtual reality. The aim of this section is to discuss and critique these mediums.

2.1. Online Social Environments

A potential test environment for dementia-friendly design experimentation is the use of online social environments (Figure 1a).

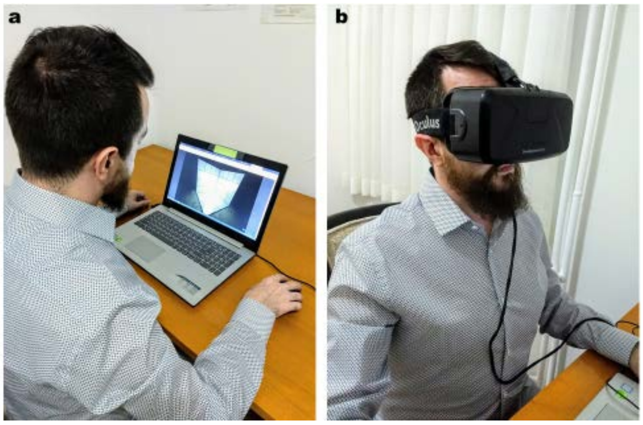

Figure 1. Online and Head Mounted Virtual Reality Test Mediums.
a: online social environments, and b: head mounted displays are commonly used as virtual reality test mediums.

Online social environments are becoming accepted as credible tool for social studies (Heldal ao., 2005; Friedman ao., 2007: 252). Researchers have indicated that people tend to behave in a very similar way when in Second Life as they would in real life (Heldal ao., 2005; Yee, 2007: 115). Users seem to react naturally to social space even though such environments are not immersive (Heldal ao., 2005). Online environments like Second Life have some distinct advantages. It can be argued that creating content in such environments is quick and cheap. All that is needed is making a 3D model of the building and placing it in the virtual environment, so no time is wasted on construction issues that might arise in real life models. This also means that adjusting a model can be done very quickly too. Research implies that online (even forum like ones) test environments function as a more generalized simulation than that of a mathematical simulation tool (Yee, 2007: 115). Equipment wise, what a researcher needs to use is a midrange computer and an internet connection. Furthermore, the usage of the software is free, which means that many users will be able to access such an environment with ease. This can increase the number of potential test subjects as everyday millions of users spend an average of 22 hours a week interacting with each other thorough avatars (Griffiths ao., 2003: 81; Yee, 2006a: 309; Yee, 2006b: 68). Additionally, visitors can come and go as they please, as opposed to a laboratory-based test environment. Visitor behaviour can also be closer in quality to real-life behaviour. Further, creating content and placing it in such an environment is relatively cheap, which means that a test building can be placed for prolonged periods of time there.

One of the major issues in online social environments is the lack of realism, which can lead to users feeling detached from the environment they are experiencing. Another issue, which could be suggested is the quality of immersion, since users have to see the environment through a computer screen, they will not feel as immersed as the other two methods which we are going to discuss (Immersive environments and head mounted displays) and as such this might cause their reactions to be less realistic (Wolff ao., 2007: 11). However, research shows that online virtual environment users behave in a very similar fashion to real-life (Friedman ao., 2007: 252). Researchers are using Second Life as a viable tool to evaluate social trends (Yee, 2007: 115) and as such we think that this medium would be sufficient for tests that might require long periods of time, a large sample size, and multiple test subjects to be present simultaneously.

2.2. Immersive Virtual Environments (IVEs)

Another test medium available in VR is IVEs (Figure 2). This technology first existed in 1965 as a lab-based idea (Slater, 2009: 560; Sutherland, 1965). It is usually a room with graphics being projected on its surfaces, usually referred to as a CAVE (square shaped room, Figure 2a) or OCTAVE (octagon shaped room, Figure 2b).

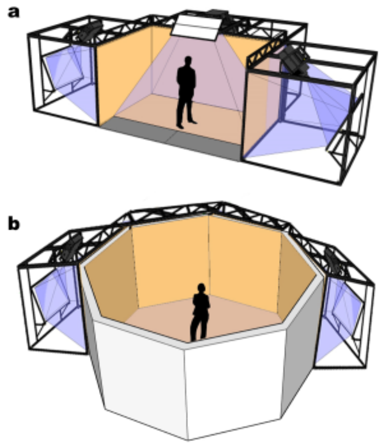

Figure 2. Immersive Virtual Environments (IVEs)
a: CAVE (cave automatic virtual environment; 3 walls and a floor), and b: OCTAVE (octagon CAVE; 8 walls and floor) are immersive virtual environments and can be used in virtual reality experiments. In the OCTAVE image, projectors were not shown on all the walls for image rendering purposes.

The number of surfaces displaying data can vary from three, upwards. The advantages of using such a method is that it provides a high level of realism, as test subjects literally step into the virtual model being tested, which gives IVEs an advantage over desktop-based methods. This means that test subjects are highly immersed in the VEs and as such would react to it in a more realistic manner. A wealth of presence research indicates that people in such environments react exactly as they would in real life (Slater, 1994: 130; Slater, 1999: 560; Slater, 2009: 240) or in low fidelity scenarios (Pertaub ao., 2001: 68; Roberts ao., 2006: 116). Mel Slater points out that in an immersive environment almost all test subjects avoid colliding with virtual objects even though they know that they are not there (Slater, 1994: 130). Also, participants usually respond in a realistic manner to events shown to them in IVEs (Slater, 2009: 560). Such environments have been used as an effective tool for social studies (Blascovich ao., 2002: 103; Jang ao., 2002: 11; Pertaub ao., 2001: 68) particularly in spatial cognition (Peruch and Gaunet, 1998: 881), education (Roussos ao., 1999: 247; Salzman ao., 1999: 293) and psychotherapy (Rothbaum ao., 1997: 291, Rothbaum ao., 2000: 263; Vincelli, 1999: 214). In numerous cases they were successfully used to treat social phobias (Anderson ao., 2003: 240; Harris ao., 2002: 245; Hodges ao., 1995: 27; Molinari ao., 1998; Rizzo ao., 2000; Roy ao., 2003: 411; Slater ao., 2003: 240; Stanney, 2002; Wiederhold ao., 1998: 97) and post-traumatic stress disorder (Hodges ao., 1999: 7; Rothbaum ao., 1999: 263). Research also shows that IVEs can evoke real emotions and mental activity as a real situation would (Brogni, 2011; Regenbrecht ao., 1998: 233). Any adjustments to the model can be made quickly and easily. Furthermore, since such an environment is lab-based, environmental factors can be controlled (such as lighting and time limits), which enables the researcher to specifically focus on the variables or elements that he wants to study.

Giving that a CAVE or OCTAVE are a lab-based environment, they would have some disadvantages associated with them. For example, the amount of people that can visit them at once is limited due to the size of the room. Additionally, people cannot stay there for long periods of time because the equipment is delicate a researcher must be present with the test subject at all time (it is also a health and safety issue). This means that the reactions of test subjects might not be as natural as looked for. Still even with such disadvantages, IVEs are the preferred test method for short-term experiments. Because IVEs provide a high level of immersion that is akin to that of constructing a life-sized model of the environment while at the same time having the flexibility of using 3D virtual models.

2.3. Head Mounted Displays

Head mounted displays (Fig. 1b) are another VR test medium, and they have the same advantages as the immersive environments (CAVE, OCTAVE) (Wolff ao., 2007: 11). Head mounted displays allow for a very high level of immersion and the content they provide can be created and edited quickly (Wolff ao., 2007: 11). The main disadvantage about head mounted displays, is that the equipment which a test subject must wear is heavy and it can cause discomfort. Furthermore, the low field of view it provides has been linked to motion sickness and a lower sense of presence which is likely to impact the awareness, attention, and action of users (Wolff ao., 2007: 11). Motion sickness can be a major disadvantage, as people tend to lose focus and interest when they are fatigued. These drawbacks might become clearer when elderly people who might have early dementia symptoms are using head mounted displays. Further, issues might arise if the experiments incorporate the use of real objects rather than virtual ones, as test subjects cannot see their bodies when wearing such displays. This inability to see their own bodies can also lead to a lower immersion quality which translates to less realistic responses.

3. Critique of Assessment Methods of Virtual Environments

Methods used in measuring presence in VEs are varied and no single method is universally accepted. For the evaluation of measurements in VEs, a single reference was used (Van Baren, 2004). However, this reference is the main resource for evaluating such measurements and it is a comprehensive review of 106 references of the most important researchers in the field (Van Baren, 2004). Methods used in that evaluation were either subjective or objective. Subjective methods included post-test questionnaires, continuous assessment methods and subjective qualitative methods. Questionnaires are the most frequent data collection method of presence used (Van Baren, 2004). Performing questionnaires is generally cheap, easy to prepare, analyze, and is not intrusive. Furthermore, questionnaires have high face validity, and as they are administered after the test, they do not need special arrangements that may disturb the test (Tcha-Tokey ao., 2016: 33; Van Baren, 2004). Furthermore, a more recent study showed that questionnaire completion in VR does not alter the measured presence but can increase the consistency of the variance (Schwind ao., 2019). However, questionnaires depend on the participant's memory of the experience, and generally test subjects are prone to suggestions and hints in the questions (Van Baren, 2004). These limitations, associated with questionnaire usage, can cause the data collected to be biased. Therefore, care must be taken when defining the questions so that they do not mislead the research participant.

Continuous assessment methods rely on feedback the subjects are giving during the experiment. Continuous assessment methods can overcome the earlier limitations of the post experiment questionnaire method (Van Baren, 2004). However, the main drawback of continuous assessment methods, is that they cause disruptions to the experiment, which can make the whole procedure invalid. Other qualitative methods such as interviews, video recording, asking the test subject for written feedback or thinking aloud sessions provide an abundance of data and information (Van Baren, 2004). This is both an advantage and disadvantage at the same time. Test subjects are free to give as much data and information about the experiment as they want leading to a deeper understanding of the results. However, analyzing data produced from qualitative methods is time consuming and is very dependent on the researcher's interpretation (Van Baren, 2004).

Objective corroborative methods can include examining facial expression, postural expression and task performance. One major advantage to these methods is that they are not affected by the participant's or examiner's interpretation. They depend on measuring automatic responses of test subjects (Van Baren, 2004). Further objective means for data collection may involve wearing equipment (heart rate, skin temperature, skin conductivity and eye tracking, brain activity). The presence of such equipment can affect test subjects overall experience and require some time for them to get used to. A general disadvantage of such measures is that the intended attributes cannot be isolated, and therefore the validity of the data might be affected (Van Baren, 2004).

4. Using Virtual Reality to Assess Architectural Environments

In architecture, the architect depends on his experience when trying to design and produce a building. The knowledge of materials, space and building methods is gained through observation and experience gained from sometimes disastrous trial and error (Addington and Schodek, 2005). Apart from architectural drawings and images of 3D models the client is usually buying a product that they cannot see fully until it is constructed in real life (Aouad ao., 1998: 1; Barrett and Stanley, 1999; Bucolo ao., 2001: 690; Patel ao., 2002: 1093). Even when using 3D reconstruction video records, the angles, and areas the client sees are limited (Patel ao., 2002: 1093). Thus, experimental buildings were used in architecture. For example: Sky Ear (Bullivant, 2005: 8), Scents of Space (Bouman, 2005: 14; Haque, 2004; Fox and Kemp, 2010), H2O Expo (Kronenburge, 2007; Spuybroek, 2004). However, making these buildings is very expensive and time consuming. Amending or adjusting them would also be very difficult for the same reasons. A research project like this would not have enough funds nor time to experiment on that capacity. Because of that another test medium had to be found. Consequently, studies were performed using virtual reality to assess architectural environments and how people might experience them (Table 1).

Table 1. Virtual Reality in Architectural Environment Assessment

Study participants	Virtual reality test medium	Purpose	Results	Reference
Nonarchitect people	Immersive virtual environments	Assess the influence of interior architecture forms on inhabitant emotions	Some features had positive impact and other features had negative impact on inhabitant emotions	(Banaei ao., 2020: 138)
Students and staff from a school of public health	Simulated virtual environments	Assess the effect of biophilic interventions in office on stress reaction and creativity	Participants in biophilic stimulated environment had lower level of physiological stress indicators and higher creativity scores compared to participants of non-biophilic environment (control)	(Yin ao., 2019: 1028)
Young people	Head-Mounted-Display system	Assess the usefulness of using immersive virtual reality when performing a collaborative Information Architecture design task-card sorting, with geographically separated participants	Usability was higher for the immersive virtual reality form compared to conventional in-person card sorting	(Narasimha ao., 2019: 175)

Nursing faculty	Head-Mounted-Display system	Assess multiple design options in virtual reality	Choice of a room that best support nursing work	(Wingler ao., 2020: 129)
Students	Head-Mounted-Display system	Develop teaching/learning methodologies	Students prefer virtual reality over the most common day-to-day teaching tools	(Angulo, 2015)
University Students	Head-Mounted-Display system	Assess behavioral compliance for dynamic, static or no signs in a virtual environment	Static and dynamic were efficient in changing behavior compared to no signs	(Duarte ao., 2014: 1367)
Young, healthy people	Immersive virtual environments	Assess the effect of seemingly moving walls with informative graphics on them on the performance and mood of people	Surround projection or physically moving walls are likely to be beneficial in the classroom setting	(Adi and Roberts, 2011b: 25)
Online focus group	Online social environments	Assess if interactive building is more appealing than static building	Interactive buildings are more appealing and attractive than static buildings	(Adi and Roberts, 2011a: 189)
Students, employees of construction companies, and firefighters	Stimulation workstation	Assess how emergency signs facilitate way finding in a building	Positive impact of emergency signs on way finding, and difference in way finding related by participant characteristics	(Tang ao., 2009: 722)

The table is showing studies used virtual reality to assess architectural environments, and how people might experience them.

The use of virtual reality (VR) visualizing methods is common in architecture. What is meant here is that architects often use virtual 3d models of buildings to produce rendered images or fly through videos that they show to clients and some potential users (Aouad ao., 1998: 1; Barrett and Stanley, 1999; Patel ao., 2002: 1093). The use of this type of VR visualizing methods, focuses mostly on construction methods rather than design elements (Patel ao., 2002: 1093). The main issue with this approach is that architects tend to show clients what they, as designers, want them to see without giving the client the ability to navigate and experience the space on their own (Barrett and Stanley, 1999). It can also be argued that the virtual models shown to clients and users tend to be at the final stages of design when most decisions have been taken (Figure 3). However, models placed in virtual environments such as the CAVE (cave automatic virtual environment), OCTAVE (octagon CAVE) or Second Life like environments tend to give the client (users of the building) a high level of freedom enabling them to experience every part of the building and interact with it (Patel ao., 2002: 1093).

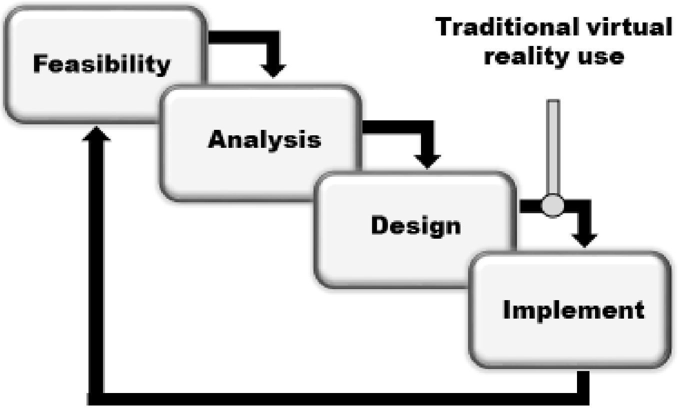

Figure 3. The Traditional Use of Virtual Reality Visualization in the Design Process.
Virtual models are usually used in the final stages of design; after feasibility and analysis are decided and just before the implementation of the project.

5. Using Virtual Reality to Treat Mental Health Disorders

Virtual environments (VEs) have been used earlier to effectively treat psychological illnesses such as phobias, and other mental issues such as trauma. Papers in computer science indicate that VEs are useful tools that can produce meaningful results and that people react in them in the same manner as they would in real life (Slater, 1994: 130; Slater, 1999: 560; Slater, 2009: 240). Research done in this field also suggests that, when measured in similar scenarios, the human brain exhibits the same level of neural activity in both virtual and real scenarios (Anderson and Rothbaum, 2003: 240; Harris ao., 2002: 543; Hodges ao., 1995: 27, Hodges ao., 1999: 7; Molinari ao., 1998; Rothbaum ao., 1997: 291; Rothbaum ao., 1999: 263; Rothbaum ao., 2000: 1020; Roy ao., 2003: 411; Slater ao., 2003: 240; Stanney, 2002; Vincelli, 1999: 214; Wiederhold ao., 1998: 97). For example, in shell shock treatment, where the procedure focuses on having users go through similar war like scenarios, it is almost certain that users were reacting to virtual environment as if it is real. Furthermore, in such cases it can be argued that users are interacting not only with the environment (Hodges ao., 1999: 27; Rothbaum ao., 1999: 263), but also with objects (avatars) in the environment (Anderson ao., 2003: 240; Molinari ao., 1998; Roy ao., 2003: 411; Slater ao., 2003: 240), or the cause of phobia itself such as, heights and flying (Hodges ao., 1995: 27; Regenbrecht ao., 1998: 233; Wiederhold ao., 1998: 97). But the main interaction is guided through the presence of a therapist who uses and controls these objects the way it fits the treatment procedure (Crowe ao., 1972: 319; Hodgesao ao., 1995: 27; Kaplan ao., 1991; Marks and Gelder, 1965: 571). What the focus of future research should be is to assess the effect of the building itself on the user with minimal interference from the designer or owner; and to isolate and study what effect buildings might have on their users.

In general, papers reviewed on the matter of the use of VEs in the treatment of phobias established two conclusions. The first conclusion is that VEs are as good, if not better, in treating phobias than real life environments, and have the advantage of allowing high control, and tailor fitting the required environment to the exact needs of the individual’s treatment (Molinari ao., 1998). Indeed, there are over a hundred research paper within that reference that agrees and reaches the same conclusion. The second conclusion is that, when using VEs, subjects react in the same manner as they would do in real life (Pertaub ao., 2001: 68; Roberts ao., 2006: 116; Slater, 1994: 130; Slater, 1999: 560; Slater, 2009: 240). However, one major critique about these reactions is the lack of physical interaction between the subject and the environment (Anderson ao., 2003: 240; Hodges ao., 1995: 27, Hodges ao., 1999: 7; Molinari ao., 1998; Regenbrecht ao., 1998: 233; Rizzo ao., 2000; Rothbaum ao., 1999: 263; Roy ao., 2003: 411; Stanney, 2002; Wiederhold ao., 1998: 97). For example, phobia treatment using VRs is based on exposing the patient gradually to their fear (Crowe ao., 1972: 319; Hodges ao., 1995: 27; Kaplan ao., 1991; Marks and Gelder, 1965: 571). This means that the person treating them is the one who interacts with the patient and controls how the treatment session goes. Also, in shell shock treatment, where the patient goes through a premade scenario, there is no interaction with the environment but only exposure to different conditions (Hodges ao., 1999: 7; Rothbaum ao., 1999: 263). In VEs treatment sessions, subjects can be guided to interact with one isolated aspect, such as the surrounding environment (in shell shock or post-traumatic stress disorder treatment) (Hodges ao., 1999: 7; Rothbaum ao., 1999: 263) or objects (avatars) in the environment (in anxiety, public speaking or phobia treatment) (Anderson ao., 2003: 240; Molinari ao., 1998; Roy ao., 2003: 411; Slater ao., 2003: 240) or the cause of phobia itself (in acrophobia treatment) (Hodges ao., 1995: 27; Regenbrecht ao., 1998: 233; Wiederhold ., 1998: 97). The main interaction is guided through the presence of a therapist who uses these objects the way it fits the type of the treatment.

6. Virtual Reality and Dementia- Friendly Building Design

Dementia-friendly hospital design was defined as an integration of key principles that protects maximum independent function without inducing anxiety (Parke and Friesen, 2007). Older adults with dementia suffer from reduction in memory, reaction time and place orientation. Those with dementia also have poor mobility and grip, limited reaching range, and susceptibility to delirium, incontinence, dehydration, hypotension and falls. Therefore, to promote safe environment and maximize independent function for dementia patients, architectural design must aim to improve patient vision and recognition by removing away attention distracting objects, providing direct attention towards environmental cues, and highlighting or camouflaging key features in the surrounding environment (Parke and Friesen, 2007). Suggestions of ideal dementia-friendly hospital design were made previously, but effectiveness of such a design in improving the safety of dementia patients was not tested (Parke ao., 2017: e62). Therefore, to reduce the expenses of performing such an assessment in real buildings, we are suggesting the use of VR in assessing dementia- friendly hospital design before implementing dementia- friendly features in real-life settings.

Generally, there are thirteen major aspects that recommended for consideration when designing a facility for older adult care. These aspects were also recommended for dementia-friendly hospital design, and they include: lighting, color, flooring, walls, hallway doors and windows, handrails, way findings and signage, walkways and ramps, acoustic considerations, parking, equipment and technology, furniture, elevators, and washrooms. All these aspects were discussed in detail in Code Plus (Parke and Friesen, 2007). We are herein proposing the use of these aspects in VEs to assess the possible feeling of dementia patients and the usefulness of these aspects before applying them on actual buildings to avoid unnecessary expenses that can be implemented for other services. An example of aspects that can be assessed using VR includes avoiding the use of orange, red and brown colors in the hospital signage, as those colors look the same for dementia patients. Another example is voiding the placement of lights in a way that they can cause shadows. Because people with dementia see shadows as holes. Furthermore, some exits must be hidden with plants or camouflaged by the same color of the wall, so “wanderers” do not get agitated if they cannot open some doors. Alongside testing these features, a VR study can also be used to assess the ideal height of shelves, easy possible ways to access bathrooms in each patient room, using ramps vs. stairs, and press calling buttons as part of the patient’s bed vs. being on a table nearby the patient. VR stimulation can be used on different scenarios of the health facility design. Those design scenarios can be tested on 3 groups of participants, including a control group of healthy people, a group of elderly healthy volunteers, and early onset dementia patients (this term refers to dementia that first occurs in a person under age 65. early onset dementia patients are less vulnerable than late onset dementia patients, which happens after the age of 65). Data can be collected afterwards from ECG tools which measure brain activities throughout the VR sessions, and by questionnaires filled by the participants.

Assessment of dementia- friendly building design can be achieved using any of the three VR major test mediums, which include: online social environments, immersive virtual environments, and head mounted displays.

7. Future Study Highlights and Conclusion

In this review, we suggested the usefulness of using VR to assess elderly-friendly hospital designs before the actual physical implementation of those designs in real life. The main purpose was to propose the idea of implementing VR in the assessment of architectural design for elderly patients caring facilities, especially those patients who have cognition and orientation impairment such as dementia, so these facilities become more efficient and safer for dementia patients and optimally reduces the cost of the healthcare. The main proposed method in such assessments, is by using VR headsets on volunteer participants. The headsets can either be HTC VIVE (has handles and sensors) or Oculus VR systems. Volunteers can use these VR systems while they are secured in their place to avoid falling (such as using harnesses to ensure participants safety). ECG tools can also be used in combination with the VR sets to measure brain activity. To collect data about the participant experience, questionnaires can be filled by the study participants. The volunteer users can be divided into 3 groups including a control group of healthy people, a group of elderly healthy volunteers, and early onset dementia patients. We conclude that VR is a well-established method to assess architectural designs, and therefore we proposed VR as a tool to assess elderly-friendly and dementia-friendly care facilities. Optimally, making these care facilities more efficient, and safe, and reducing the cost on the healthcare system.

Ethical approval and consent: Not applicable.

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