Digital Empathic Healthcare: Designing Virtual Interactions for Human-Centered Experiences

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Abstract. The evolution of the relationship between healthcare professionals and patients towards patient-centered care has emphasized the importance of understanding patients' perspectives, values, and needs. This shift has transformed decision-making from a technical standpoint to a more holistic approach integrating moral influences, driven by empathy. This research explores the transformative role of empathy, facilitated by Virtual Reality (VR) technology, in healthcare practitioners' interactions with patients. Inspired by VR's immersive capabilities, the novel specification entitled the Digital Empathic Design Voyage is presented as a foundation for operational virtual environments that empower humans to experience empathy. Through outcomes from literature and a qualitative study, this paper determines appropriate digital environment interactions relevant to a healthcare scenario. The research envisions a deeper understanding of patients, fostering human-oriented healthcare practices and solutions.

Keywords: Empathy · Virtual Reality · Digital Healthcare

1 Introduction

The relationship between the healthcare professional and the patient has been evolutionary. Patient-centered healthcare has led to increased empowerment of patients in decisions related to their medical care [1]. This entails healthcare professionals to fully understand the patients' perspectives, values, and needs [2] that have shifted the decision-making process from being merely based on technical expertise to a more holistic approach that integrates moral influences [3]. In fact, empathy is indicative to play a transformative role within the field of healthcare [4] which has led to increased patient satisfaction and treatment adherence [5, 6]. This could be attributed to the reduction in pain and anxiety associated with enhanced healthcare practitioner empathy [5, 7]. This not only improves the quality of the patient experience [8] but consequently enhances the well-being of professionals [9], which is also fundamental for empathy care to thrive in the first place [10]. Ostensibly, empathy in healthcare is therefore cost-effective [8]; for instance, in reducing medico-legal related risks [11].

Technology has often posed limitations to the development of empathic interactions [12]. In the past decades, psychology has highlighted simulation as a crucial process for comprehending the beliefs and perspectives of others [13, 14]. It has also been implied

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that empathizing and 'mirroring' people's behaviors and feelings was a critical mechanism for understanding others [15]. Virtual Reality (VR) technology has the potential to emotionally engage users and foster empathy, leveraging the technology's interactive and visual elements that enable complete immersion in a virtual space and the embodiment of a digital self [16]. Particularly within the medical field, VR has proven effective in empathy training, utilizing simulation to provide a secure environment for trainees to reproduce clinical scenarios. This approach not only elicits empathic responses but also enhances behavioral skills through practical experiences [17]. Using multi-disciplinary approaches stemming from psychology and empathic design, this paper is an initial exploration of how the empathy experienced by healthcare practitioners towards patients can be augmented via a virtual environment simulation. This is achieved by determining the appropriate design requirements for an empathy-based virtual environment applicable to a healthcare setting, which is the aim of this paper. The foundation for designing the virtual experience follows the specification entitled the Digital Empathic Design Voyage [18], targeted to elicit empathic responses. The research outcome involves a novel design guideline developed as an extension of the Digital Empathic Design Voyage [18] placing focus on healthcare practitioner empathy towards patients in healthcare facilities. The goal is to reach a step further in patient-oriented healthcare practices and solutions.

1.1 Empathy in Design

For healthcare professionals to be exposed to a virtual environment simulation designed to allow them to experience the optimal level of empathy towards their patients, designers constructing that same virtual environment would also need to empathize with the users who would use the virtual environment, hence the healthcare practitioners, and the patients themselves. Duan and Hill [19] categorize empathy into two key dimensions. Cognitive empathy concerns understanding another human's situation, whilst affective empathy refers to the emotional reaction. Research suggests that designer empathy can be optimally experienced when a balance is generated between cognitive and affective empathy responses [20, 21]. Numerous methods and techniques are employed to support designer empathy in existing design processes. One approach involves observing end-users in their environments [22], while personas and journey mapping contribute to focusing on the users' standpoint [23]. Designers have also employed empathic modeling to simulate user experiences, particularly when seeking to comprehend unfamiliar situations influenced by users having diverse physical or cognitive abilities [23]. This modeling aligns with principles from psychology, where simulation is a crucial process in grasping other people's beliefs and perspectives [13, 14]. Strickfaden and Devlieger [24] underscore the importance of practical experiences that involve both the physical and emotional aspects of designers, leading to successful design solutions. This suggests that simulation allows designers to grasp users' thoughts and feelings from a first-person perspective, facilitating empathy.

Role-play serves as a simulation technique that deepens sensory engagement [25] and, consequently, positively influences empathic connections [26]. What sets role-play apart from other simulation methods is its incorporation of the narrative. Narratives, serving as a means of representation and reasoning [27], can be deemed plausible even in less immersive scenarios, such as when watching a video [28], indicating their ability to captivate viewers. Additionally, narratives contribute to the learning process, attributed to the active involvement of designers in constructing knowledge and decision-making processes as they progress toward their predefined objective [29]. The Digital Empathic Design Voyage [18] explores the power of the narrative to elicit empathy. This paper aims to apply the above methods to develop the requirements of a virtual environment that are targeted to augment healthcare practitioner empathy toward patients by eliciting a combination of cognitive and affective empathy responses.

1.2 Empathy in Virtual Spaces

Virtual Reality (VR) denotes the digital recreation of an environment [30]. In addition to the increased accessibility resulting from the decreased costs of Head-Mounted Displays (HMD) [31], VR offers various advantages applicable to empathic virtual environments. VR allows access to situations that are hazardous, expensive, and time-consuming [32]. Research indicates a positive correlation between elevated levels of graphical and audio quality and the subjective feeling of environmental presence [33, 34]. For instance, Kisker, Gruber, and Schöne [35] demonstrated that the incorporation of environmental and haptic cues could induce physiological responses akin to those in real-life interactions. Moreover, Gromer *et al.* [36] discovered that a participant's subjective sense of presence in a VR experience could predict their emotional response to it. Immersion and presence, fundamental to the effectiveness of mediated virtual environments across various applications [37], extend beyond empathic experiences to include learning and education [38]. Table 2 outlines Slater and Wilbur's [39] definitions of immersion and presence (Table 1).

Table 1. Definitions of Immersion and Presence [39]

Phenomena	Description
Immersion	The degree to which VR stimulates the sensory receptors of users
Presence	The psychological extent to which the human denotes the virtual environment as real

By embodying the viewer, virtual reality (VR) has been shown to improve perspective-taking, particularly in situations involving empathic concern [40]. The term "embodiment" denotes the viewer's capacity to project their body onto that of the avatar within the virtual environment [41]. Schutte and Stilinović [42] claim that VR's ability to evoke empathy stems from the interactive and immersive experience attained when embodying the perspective of someone else.

Empirical case studies have explored what facilitates empathy in VR in healthcare-related applications. Zhang *et al.* [43] replicated the experience of individuals, both children and adults, including adults in wheelchairs by aligning the participants' viewpoints with the intended perspective of the user. This was achieved through the dynamic scaling of the user's virtual eye height (EH) and virtual interpupillary distance (IPD).

Therefore, the perspective of the user, through spatial scale manipulation of EH and IPD could be a critical tool to simulate the experiences of multiple user groups of different ages [43]. Li *et al.* [44] added narrative elements by developing a game prototype that helped patients suffering from depression and their caregivers obtain an understanding of each other's emotional states. Character archetypes were used for the participants to virtually interact with. Additionally, sound and music positively influenced immersion, whilst the stereo vision was crucial for emotional stimulation and embodiment effects. The effect of narrative elements was also analyzed in Hu *et al.*'s [45] study which developed two virtual environments with different levels of contextual detail that simulated scenes of people having red-green color vision deficiency (CVD). The aim was to explore the effect of contextual depth and to demonstrate whether viewers can develop empathy towards this target user group. The rich contextual elements that contribute to the narrative positively influenced the accuracy, and relevance and reduced the misconceptions of the perception of the difficulties of CVD which suggests positive influences on empathy. However, for empathy to be elicited, further explicit instructions for perspective-taking were required.

Therefore, the mechanisms applied in the above studies that fostered empathy which were related to the perspective taken combined with narrative elements including rich contextual detail are further developed in this research. Other future areas of investigation include how empathy can be experienced in VR, whether it is cognitive or affective, and how it can be evaluated. Gerry *et al.* [17] claim that current research on empathy in VR lacks extensive longitudinal analysis and recommends a mixed-method approach to evaluate changes in behavior between that observed in the virtual experience and actual circumstances. In the above studies [43–45] self-reporting was one effective approach to evaluate empathy, however further exploration and standardization of evaluation methods are required for enhanced reliability.

2 Methodology

The Digital Empathic Design Voyage [18] specification was created to empower designers to experience the optimal level of empathy towards their users in a virtual space through a combination of cognitive and affective responses. To determine the applicability of the Digital Empathic Design Voyage specification to healthcare, a guideline was developed as an extension of this specification to determine detailed environment interactions of the empathic virtual space for this context. The guideline was developed by combining knowledge from The Empathy Tool Design Strategies Framework developed by Pratte, Tang, and Oehlberg [46] that encompasses empathy tools for design, the taxonomy developed by Fisher [47] for empathy in VR scenarios, and a qualitative study conducted as part of this research to explore empathic interactions towards people living with visual impairment [48]. This paper aims to develop a novel guideline that is specific to designing mechanisms for empathy in virtual environments.

The Empathy tool design strategies framework developed by Pratte, Tang, and Oehlberg [46] is a descriptive framework developed for designers that depicts how empathy was achieved within the field of human-computer interactions and classifies them according to three dimensions: agency, perspective, and sensations. Whilst Pratte, Tang, and Oehlberg [46] explored empathic design in the field of human-computer interaction, Fisher [47] sought to understand a more generalized form of empathy, but specifically for Virtual Reality mirroring design strategies through case studies. The strategies revolved around the role taken by the viewer, ranging from the viewer being a bystander to what is happening in VR to the viewer having the autonomy to make choices and affect the outcome of the VR experience. The guideline takes inspiration from the agency classification proposed by Pratte, Tang, and Oehlberg [46] which depicts the level of interactive and narrative control of the designer over the experience.

The qualitative study [48] involved conducting workshops with 57 participants from the fields of engineering design and product design. A significant majority (74%) were male, 14% were female, and one participant identified as gender diverse. Half of the students were affiliated with the United Kingdom, while the remaining participants came from various countries in Europe, Asia, Africa, and North America. The students were in the senior stage of their studies, with 77% being familiar with empathic design. Although most students (76%) were not acquainted with the lived experiences of visually impaired users, 53% expressed a willingness to learn more. The remaining participants (24%) had a closer connection to visual impairment either through personal experience or through people they know.

The participants were invited to role-play a situated interaction in pairs for 5–10 min, involving a visually impaired client sitting in a restaurant and a participant with no visual impairment who represented the server. The goal of the role play was to take an order from a menu and analyze empathic responses. The visual impairment condition was simulated through empathic modeling using glasses that represented a severe blurred vision that presented a challenge for the participant to interact with the surroundings and read the menu. This approach of integrating empathic modeling and role-play is referred to as Empathic Empowerment [48]. After Empathic Empowerment, participants were invited to enter a multi-user virtual space that provided an initial exploration of how the restaurant scenario can be virtually transformed. The environment was accessed via Oculus Quest 2 headsets and was created using ShapesXR® which is a free-to-use 3D prototyping environment for VR. The students were instructed to explore the environment for approximately 5 min by observing, interacting with objects, and engaging with each other. The visual impairment condition was not simulated in the virtual environment as the purpose of this virtual exposure was to provide students a basis of how the interaction could be represented in VR and to expose them to technological capabilities.

Following exposure to a virtual experience, the students were then invited to visualize and reflect on the transformation of the scenario into a virtual setting. The responses were gathered through a worksheet, which contained questions related to how they would imagine themselves interacting with the space considering VR's technological feasibility. The questions were inspired by multi-disciplinary knowledge by Pratte, Tang, and Oehlberg [46], Fisher [47], and literature on empathy, empathic design, and empathy in VR. Participants were asked to reflect on multiple aspects including entering and leaving the virtual space, navigation, realism, embodiment, and social interactivity.

A mixed-method approach was applied to analyze the data obtained from the worksheets. Multiple-choice questions and those answered on a Likert scale were analyzed quantitatively, whilst open-ended questions, were analyzed qualitatively through coding.

2.1 Methodology Applied to Healthcare Scenario

The interaction involved in the qualitative study was mirrored from a restaurant environment to a healthcare facility to obtain a broader perspective of how The Digital Empathic Design Voyage [18] applies to healthcare. In this case, the scenario involved an interaction between a healthcare practitioner and a visually impaired patient in a hospital bed while having a meal. A 3D space using ShapesXR® was created for a healthcare setting that served as a basis for exploration of the interactions involved in a hospital room, as shown in Fig. 1. In the environment, the viewer takes the perspective of the patient in a healthcare facility.

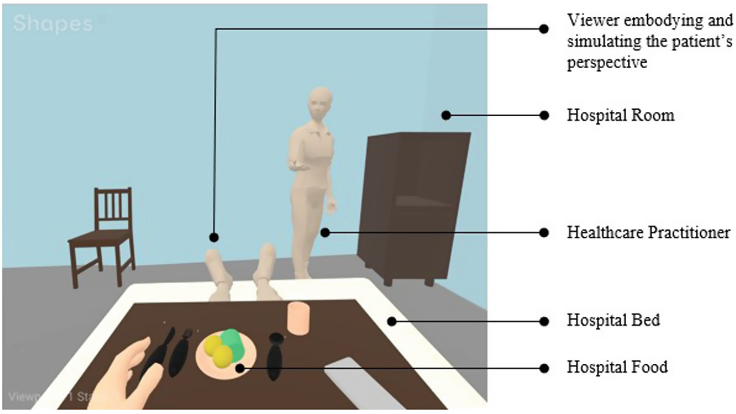

Fig. 1. First-person Perspective of Patient in Hospital accessed through ShapesXR®

The authors of this research explored the hospital room from the eyes of a patient sitting on a hospital bed by observing the surroundings and interacting with objects in front of them. The worksheet applied in the qualitative study for the restaurant scenario was adjusted for the healthcare setting. Following the exploration of the virtual environment, the worksheet was filled, to determine what would be the appropriate environment interactions for the virtual empathic environment that would facilitate healthcare practitioners to empathize with their patients.

3 Results

This section presents results obtained from the qualitative study for the restaurant scenario which were subsequently broadened to a healthcare scenario.

3.1 Restaurant Scenario Results

Table 2 presents the main results of the restaurant scenario obtained from the questionnaires submitted by the participants at the end of the study.

Table 2. Restaurant Scenario Results Obtained from the Qualitative Study

Requirements for Empathy in VR		Describing the Restaurant Scenario
	Gradual entering and leaving the space	"I want to visualize myself entering the restaurant from outside in VR"
	Freedom of Navigation	"It depends on the person or scenario, a fixed position whilst sitting at the table would be useful." "Head movement is key for immersion because you tend to look around in a new space."
	Haptic Feedback	"I want realistic interactions whilst still being aware that I am in VR."
	Vision and Sound Realism	"I want it to feel real and believable but not too realistic." "I want to hear other clients talking." "Lower realism may be helpful when the situation gets overwhelming."
	Embodiment Level	"It depends on the scenario. Embodiment of hands is sufficient when seated." "If a visually impaired person could make an outline of humans, full embodiment of the server is required."
	Human Characteristics of Viewers in VR	"I am comfortable embodying someone of a similar age as me." "It is hard to embody someone with a higher mental ability."
	Communication Level	"Dynamic communication is important but physical touch would be unprofessional between a client and a server

Participants generally preferred a gradual entry into the virtual space, either through a fading animation or an opening sequence with instructions. Head movement supported immersion, however, the level of navigation and embodiment is dependent on the context and perspective taken. Most participants desired the object interactions, visuals of the surrounding environment, and sound to be highly realistic for immersion purposes, however, certain participants noted that they wanted to feel aware they were in a virtual space. One participant noted that certain scenarios that may be difficult to engage with in real life, due to their emotional intensity, may benefit by having less realistic visuals. Background noise would ideally match the real environment, and many wanted to have the option to switch off the noise when needed in cases where a higher focus on the interaction is desired. Several participants could relate more with a client having similar characteristics as themselves, including age, gender, and physical and mental ability.

Future work requires further exploration of embodying others having different characteristics from the viewers in VR. Dynamic communication involving gestures, body language, facial and emotional recognition, and social openness were deemed highly beneficial, although these would be challenging for the visually impaired client. Physical touch, eye contact, and mimicry which involve the subconscious mirroring process of interaction leading to the imitation of speech patterns and body language [49] with a virtual agent were questionable amongst participants since this might lead to awkwardness, also because this depends on the type of contextual relationship. Physical touch between the server and client may be unprofessional. The results presented in Table 2 are therefore highly dependent on the contextual narrative and the perspective taken by the viewer.

Other requirements that the participants desired were a virtual companion to be with them in the virtual environment for operational instructions and a 2D user interface for various functionalities such as regaining access to the real world whenever necessary, troubleshooting, accessing VR environment settings, recording interactions through snapshots, videos, voice notes, text notes, and getting access to information sources. Participants also desire to replay or rewind the experience to pause and reflect, to observe themselves from a different perspective, and to improve their interactions and reactions and try alternative ones. Several participants desired feedback on the type and intensity of empathy experienced as a means of learning and improvement. However, others noted the subjectivity element of such a measure which might be detrimental to the empathy experienced since this would be viewed as a target and may be subject to creating false interactions to obtain more positive feedback and results.

3.2 Healthcare Scenario Results

Table 3 summarizes key results obtained from the worksheet for the healthcare application involving a patient with visual impairment in a hospital room which was presented in Sect. 2.1.

By mirroring results from Sect. 3.1, the appropriate environment interactions were determined for the healthcare scenario. A gradual entry into the virtual space, perhaps from outside the hospital room would be applicable as part of an opening sequence with background information. Freedom of head movement is required to mimic realistic scenarios. A highly realistic manipulation and control of objects is desirable, and a partial embodiment of hands would be sufficient due to the patient's fixed position. If the experience involves an interaction with a healthcare practitioner, full embodiment of the practitioner would be desirable. A semi-level of realism would be appropriate ensuring viewers are immersed in a 3D environment whilst still being aware that they are in a virtual space. Background noise would ideally match the real environment, with the option to switch off the noise when needed in cases where a higher focus on the interaction is desired. Dynamic communication is highly valuable, whilst also considering the professional relationship between the patient and caregiver. Other requirements including a virtual companion, a 2D user interface, the option to replay or rewind the experience, and taking the perspective of someone else such as the caregiver are all deemed to add value to the experience.

Table 3. Requirements for Empathy in VR Results Applied for Healthcare Scenario

Requirements for Empathy in VR	Describing the Healthcare Scenario
Gradual entering and leaving the space	Visualizing the journey helps the viewer gradually immerse in the scene
Freedom of Navigation	Natural head movement is required; however, the patient in the hospital bed requires a fixed position
Haptic Feedback	Realistic interactions are desirable whilst still being aware of the virtual space
Vision and Sound Realism	High visual realism but not to the extent of photorealism. Contextual background noise is required
Embodiment level	Partial embodiment of hands is sufficient for the patient's perspective
Human Characteristics of Viewers in VR	Similar characteristics between viewer and patient apply, except vision
Communication level	Dynamic communication is critical in maintaining a professional relationship with the healthcare practitioner

4 Discussion

When comparing a visually impaired client in a restaurant and a visually impaired patient in a hospital, results demonstrate common elements in the environment interactions such as the level of navigation, embodiment, and object interactivity. However, the contextual narrative of both scenarios is very different. The hospital environment may subject the viewer to a more vulnerable state of mind. The narrative presented to the viewer as they gradually enter the hospital room may elicit stronger emotions. The communication in the interaction between a healthcare practitioner and a patient versus that of a restaurant server and a client would also differ significantly. This implies that a lower level of vision and sound realism may be required in the healthcare scenario to prevent the viewer from feeling overwhelmed. Therefore, the context plays a critical role the designing an empathic virtual space. Future work requires further development on how the narrative influences the resulting empathic responses. In this case, the narrative should be built around how healthcare professionals and servers are trained to communicate with people living with visual impairment to serve as learning experiences for practitioners needing to develop empathy towards visually impaired patients in a hospital setting.

Different scenarios and user conditions may present different design requirements in VR. The qualitative study performed in this research helped determine the requirements for a visually impaired client in a restaurant. However, performing studies in physical settings for other scenarios including other human conditions and environments might be time-consuming and costly. This paper broadened the knowledge obtained from the qualitative study to another scenario by transforming the restaurant environment into a hospital room. By combining knowledge developed by Pratte, Tang, and Oehlberg [46], Fisher [47], and the outcomes of the qualitative study [48] conducted in this research which led to the results presented in this paper, a novel guideline was developed to support designers in determining the appropriate design requirements for any specific scenario targeting empathy in VR. The guideline, presented in Table 4, describes the specific environment mechanisms for empathy in VR and is presented as an extension to the Digital Empathic Design Voyage specification [18]. Such design requirements are listed in the 'Design Factors' column and are applied at a certain level of intensity. The intensity depends on the application itself, including the perspective taken by the viewer, the narrative role of the viewer, and the contextual narrative. The intensity of each factor is categorized according to three levels: High, Mid, and Low; however, these represent a spectrum of different levels of intensity that can be intermixed and combined as deemed most appropriate for the application. The intensities for each design factor determined for the healthcare scenario being considered in this paper are presented in Bold format below.

In this analysis, the environment interactions were determined for experiencing the perspective of visually impaired patients from a first-person perspective. The design guideline presented in Table 4 may differ depending on the perspective taken, therefore the design requirements would need to be determined for every role taken by the viewer in the same application. Relevant design requirements would also need to be established for any virtual agents that the viewer would be interacting with, such as their level of embodiment and realism. According to the Digital Empathic Design Voyage specification [18] the viewer is encouraged to embody multiple perspectives of the same scenario to holistically experience a combination of cognitive and affective responses. In this case, after the viewer takes the perspective of the patient, the same scenario is repeated by embodying the perspective of the healthcare caregiver.

Besides embodying multiple perspectives, this guideline strengthens further the balance between the prescribed narrative of the scenario and the viewer's level of agency and empowerment over the outcome of that scenario, which were key contributors to eliciting empathy in the qualitative study performed [48] and is relevant to healthcare scenarios as demonstrated in Sect. 3.2. The extent to which the viewer's agency determines the outcome of the scenario requires further empirical analysis, including in the field of healthcare, however, this guideline provides the required support for designers to achieve the right balance applicable to their scenario through enhanced structure and visualization, whilst also considering technological characteristics determined by VR. Pre-trials in VR are recommended to ensure the right balance is achieved between what the narrative communicates to the viewer and the viewer's level of autonomy whilst also determining the implications for healthcare practices. This guideline is subject to development following further research and technological advancements.

Limitations of this qualitative study are associated with potential biases from participants due to the relatively small sample size and cultural heterogeneity [50]. Future studies should be conducted to expand both the size and diversity of the sample. A challenge in designing the virtual environment is related to the acquisition of sufficient information from real patients and healthcare practitioners to construct the narrative. The Empathic Empowerment Scale [48] presents a novel evaluation system for analyzing empathic responses during the virtual experience. Future work of this research

Table 4. The Digital Empathic Design Voyage: Environment Interactions Guideline

Design Factors	High/ +	Mid	Low/−
Navigation Factors			
Navigational Agency	Full Freedom: Navigation of the virtual environment as in the real scenario. **Freedom of head motion**	Partial Freedom: Navigation of the space using controllers. **A virtual companion assists with navigation**	Fixed Position: **Navigation is fully guided by a virtual companion or by the narrative**
Narrative Factors			
Narrative Agency	Full Dramatic Agency: Choices have a consequence on the outcome. Full manipulation of the outcome	**Mixed Approach: The VR environment has partial control of the outcome**	Passive Witness: The VR environment has full control of the outcome. Highly structured narrative
Realism of Narrative	**High Contextual Depth: High level of contextual richness communicated by the environment**. Use of multi-sensory engagement such as aromas and spatial diegetic sound that matches the real scenario. High level of spatial depth through lighting and shadows. The narrative occurs in real-time. The narrative is related to real-life scenarios or based on facts. The narrative involves high emotional engagement	Mid Contextual Depth: Good level of contextual depth and multi-sensory engagement. Use of virtual and audio cues that support the narrative. The narrative may not happen constantly in real time. **Presence of virtual companion. Partial use of user interface during the experience**	Low Contextual Depth: Limited contextual depth and multi-sensory engagement. High use of virtual and audio cues to guide the viewer. High dependency on virtual companion and user interface. The narrative does not occur in real-time. The narrative involves low emotional engagement
Sensory Factors			
Visual Agency	**Full visual exploration: Limited by the size of the physical space**	Medium visual exploration: Limited by 1–2 obstacles in the real or virtual environment	Limited visual exploration: Obstacles in the real or virtual environment limit exploration
Object Agency	**Full manipulation and control: In the same manner as the user's reference population**	Medium manipulation and control: High level of realism achieved via controllers	Limited manipulation and control: Low level of realism with controllers

(*continued*)

Table 4. (*continued*)

Design Factors	High/ +	Mid	Low/–
Realism of Visuals	High Realism: The environment is photorealistic, denoted by high graphic resolution, realistic forms, materials, textures, and stereo vision. Avatars' appearance is highly realistic	**Semi-Realism: The environment and avatars' appearance are not realistic but have 3D form and some implementation of materials and textures**	Low Realism: The environment and avatars' appearance are not realistic and may be abstract or in 2D form. Limited use of materials and textures
Realism of Interactions	High Realism: Interactions are matched with real objects. **Multi-sensory interactions include tactile and haptic feedback,** ground vibrations, temperature, and humidity conditions. **Dynamic interactivity with other avatars**	**Mixed Realism: A combination of high and low realism of interactions is achieved**	Low Realism: Interactions are virtual. Limited multi-sensory and physiological interactions. Low interactivity with other avatars
Embodiment Factors			
Role Agency	Full Embodiment: Full body visualization and interaction. Possibility of appearance customization. Option to control the level of embodiment	**Partial Embodiment: Head, torso, and hands visualization and interaction. Possibility of appearance customization. Option to control the level of embodiment**	Limited embodiment: No visualization but may include interaction via controllers. No possibility of appearance customization
Role Characteristics	Fully Matched: Physical and cognitive characteristics between the viewer and the role taken are very similar	**Partially Matched: Few physical and cognitive characteristics between the viewer and the role taken differ**	Not Matched: Physical and cognitive characteristics between the viewer and the role taken are not similar

involves conducting an empirical analysis of The Digital Empathic Design Voyage with this evaluation system in VR.

5 Conclusions

This research explores The Digital Empathic Design Voyage specification [18] to support the development of a virtual environment to elicit empathy by healthcare practitioners toward their patients. By combining knowledge by Pratte, Tang, and Oehlberg [46], Fisher [47], and the outcomes of the qualitative study [48] conducted as part of this research to analyze empathy in VR, this paper presents a unique design guideline, presented as an extension of The Digital Empathic Design Voyage [18], to determine the most appropriate environment interactions for any application driven by empathy. The guideline was applied for one scenario involving a virtual environment that would empower healthcare practitioners and caregivers to obtain a deep understanding of visually impaired patients' experience in a healthcare facility. The outcome of this paper serves as a foundation for the exploration of other patients in different scenarios and of other applications requiring empathy. Other scenarios include having remote patient-physician consultations, telemedicine settings, physical outpatient clinic consultations, or procedure simulations. This research aims to take a significant stride toward developing the next generation of patient-centered healthcare practices intended to augment inclusivity and social value through practical and empowering experiences. Future work involves conducting empirical analysis in collaboration with healthcare professionals and visually impaired individuals to obtain a deeper understanding of healthcare scenarios. The resulting empathy will be also analyzed using the Empathic Empowerment Scale [48]. Therefore, the Digital Empathic Design Voyage [18] combined with the Empathic Empowerment Scale [48] provide the groundwork for designing and evaluating future virtual empathic experiences in industrial, research, and pedagogical settings across multiple disciplines including design, architecture, computer science, and any other field that requires a deep understanding of others, particularly those having different characteristics, such as age, physical and cognitive ability, and are therefore deemed highly valuable within the domain of digital healthcare.

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