Switching User Perspectives: Using Virtual Reality to Understand Users for User Experience Research and Design

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Virtual reality (VR) technology can be used as a tool in user experience (UX) research and design to understand and empathize with users. Several works show that the perspective-taking ability of VR in a simulated, immersive environment is helpful in fostering empathy and understanding, which is a crucial first stage within the UX design thinking process. However, it remains unclear how VR could be used to understand multiple users, reflecting common UX research projects, and what kinds of perspective-taking interaction better facilitate empathy and understanding of the users. This thesis introduces switching perspectives interaction in VR to understand different user problems, reflecting the nature of UX research. We conducted a mixed-methods, between-participant study comparing the switching perspectives to two different user perspectives in order to investigate how different types of perspective-taking influence researchers' and designers' understanding and empathy for user problems and needs.

The findings show that both affective and cognitive empathy are fostered across the different perspectives, shown through the avatar embodiment questionnaire and the interpersonal reactivity index questionnaire. The qualitative data indicate that Switching Perspectives influences participants to see the bigger picture of the user problem, prompting them to ideate solutions that impact both user groups compared to Single-Perspective. With these findings, my thesis aims to explain how and why these understandings and empathy are facilitated towards specific user groups. I conclude this thesis with suggestions on using Switching Perspectives and Single-Perspectives in UX research, with recommendations on the general usage of perspective taking in VR to empathize better and understand user problems.

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Dedication

To my mom and dad, for all the support, love, wisdom, and encouragement. I will be forever thankful and grateful for the sacrifices you made. Thank you for believing in me, and I couldn't have done without you.

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List of Abbreviations

AEQ Avatar Embodiment Questionnaire.

HMD head-mounted display.

IRI Interpersonal Reactivity Index.

RTA Reflexive Thematic Analysis.

SoE Sense of Embodiment.

UX user experience.

UXRD user experience research and design.

VR virtual reality.

Chapter 1

Introduction

Virtual reality (VR) affords new spaces, interactions, and activities for researchers and designers to explore, investigate, and utilize in their design process. Specifically, the use case of VR in experience design, such as user experience (UX), has been increasing. Applications range from collaborative tools that connect design team members in an immersive, online environment to tools that support design thinking; the iterative approach to empathize, define, ideate, test and improve solutions [60]. While it is mostly used as a design tool [49], VR can also be used in the earlier stages of design thinking, such as the empathizing and defining stages, due to its perspective-taking abilities, which show strength in fostering understanding and empathy towards people. However, limited works explore how VR facilitates distinctive empathy and understanding of users in UX research and design and how it can be used in the earlier stages of design thinking. It is unclear how VR could be used to understand *multiple* users, reflecting UX research projects, and what kinds of perspective-taking interaction better facilitate empathy and understanding for UX researchers and designers, which can aid their design process.

This thesis focuses on the role and potential of perspective-taking in VR to better understand users. Specifically, I investigate how providing different perspectives influences researchers' and designers' understanding of users. To do so, I introduce a novel perspective-switching interaction method allowing participants to see multiple user perspectives within the same scenario, with a user study that compares it to two single-perspective interactions, each representing one of the roles encompassed in the switching condition. The study results compare how seeing from different perspectives through VR impacts human empathy and understanding, which extends to their prosocial behaviours measured by number of design solutions ideated after identifying user problem and needs. Based on the findings, I propose an interaction technique in VR that offers a unique form of perspective-taking,

supporting researchers and designers in understanding and empathizing with their users by providing a holistic view of the user problems, highlighting the use case for VR in the early stages of the UX research and design process.

1.1 Motivation

VR technology involves using a head-mounted display (HMD) and handheld controllers, that provide a simulated, computer-generated environment in which the person can explore and interact with their surroundings. For researchers and designers, this virtual environment provides "an opportunity to collect data from early stages of the design process" [61], where they can gather user insights, needs, and expectations with high accuracy and good ecological validity that is difficult to access in real-life settings [61]. This capability is particularly valuable in UX research, especially in design thinking. Understanding and empathizing with users is the earlier stages of the design thinking, emphasized as the "centerpiece of a human-centered design process" [57], forming the foundation for subsequent stages such as ideating, prototyping and testing the solutions. Therefore, VR can be used as an empathizing and understanding tool, supporting researchers' and designers' design process.

However, it is unclear what perspective in VR is effective to take, and under what circumstances they meaningfully support the UX empathizing process. Prior work has primarily examined limited perspectives – single, specific groups with a focus on fostering empathy and changing perceptions toward vulnerable populations [4, 32, 3, 33, 28, 62] rather than addressing its usage in the UX process. Feeling empathetic to vulnerable groups and changing perceptions merely shows VR as a perspective-taking machine, not a perspective-taking tool that aids the entire UX process by understanding user needs, problems, wants, and issues. Researchers and designers need to keep in mind their users, as well as the interconnected users and stakeholders who will be impacted by the solutions produced and applied. Here, VR as a perspective-taking tool should not be limited to one type of user, but should be used to understand all the different users who are involved in the problem area that needs to be tackled. No work has been done that leverages the capabilities of VR in perspective-taking, whereby people can take *multiple* perspectives in a virtual environment, and how that impacts their understanding of what users say and do.

Through embodiment and taking perspectives, VR provides a vivid experience that increases empathy levels and facilitates prosocial behaviours towards the group that users

observe and interact with in the virtual environment [37]. This suggests that VR is an optimal tool for UX researchers and designers with a goal of creating a solution to help users, but further investigation is needed on which perspective-taking methods are beneficial in understanding multiple users. In this thesis, I introduce a perspective-switching mechanism in VR for UX researchers and designers to understand user problems, and compare the two single-user perspectives, each representing one of the perspectives in the switching condition. It aims to highlight the beneficial usage of VR as a perspective-taking tool for UX researchers and designers with a goal of understanding multiple users associated with a shared problem space.

1.2 Research Problem

Although existing works show that VR facilitates empathy to outgroups and induces helping behaviours [33, 3, 28, 62, 74, 56], it is unclear how taking the specific perspective of a user under observation impacts one's understanding of that particular target group in UX. Restricted manipulations, such as eye levels or proposal of the first-person perspective and second-person perspective as separate methods, have been done [29, 74], but no study shows the impact of being able to switch between two *different* perspectives on understanding users. The attempts to utilize VR's full capacity of observing from different groups back and forth, to understand multiple users have not been made and explored. Additionally, it is unclear how seeing from multiple perspectives might affect the understanding of problems and frustrations differently from the traditional first-person perspective of a specific user. To examine the role of different perspective-taking on understanding users for UX research and design, specifically, whether the immersive potential of VR has a positive impact on the process, a user study that compares different perspectives is needed. Therefore, switching perspective interaction methods need to be developed to determine if a certain perspective better facilitates understanding of user problems and needs, which sets the basic foundation for empathetic UX research and design.

1.3 Research Questions and Contributions

There are two research questions that this thesis explores:

RQ1. How might different perspectives (switching perspectives and single perspectives) influence researchers' and designers' *understanding and empathy* for user problems in virtual environments? To answer this question, I

conducted a user study that compares different perspectives of the user groups within a hypothetical user scenario. I compare the perspectives of medical staff, patients, and switching between those perspectives in VR, collecting data about participants' understanding and empathy towards these hypothetical user groups.

RQ2. How does being able to switch perspectives in VR influence researchers' and designers' *understanding* of user problems and *ideation* of user solutions? To address this question, I interviewed all participants after showing them the interaction method they did not experience in their task, asking questions about the switching perspective interaction in comparison to single-perspective, revealing insights on this perspective-taking method.

In addressing the two research questions, the following contributions are presented:

C1. An interaction technique for switching perspectives (two different users) in VR. I developed a working prototype that involves two avatars, and participants can switch perspectives back and forth in a VR scenario. Further details on the development process are discussed in Chapter 3 of this thesis.

C2. Results from the user study comparing the two single perspectives and switching between them in VR, which reveals that both affective and cognitive empathy were facilitated. A mixed-methods, between-participant user study is done to show how these perspectives each play a role in understanding users. The analysis shows statistical analysis with qualitative reasoning to explain the phenomena, answering RQ1 in Chapter 5 and Chapter 6.

C3. Suggestions on how switching perspective interaction, or single perspective interaction, could be used in UX research/design settings. I provide insights into how switching perspectives can be used to understand the broader context of user problems, revealing unspoken aspects of the environment that need to be addressed and require design solutions. I also show that single-perspective interaction can foster an in-depth understanding of a single user and their relationship to other stakeholders, though careful consideration is needed in selecting which user's perspective to take in Chapter 6, Section 6.5.

1.4 Thesis Organization

This thesis is organized into the following chapters:

- Chapter 2 reviews the literature and existing works on VR as a tool for UX research and design, what empathy is in UX research, what aspects of VR make it advantageous in fostering empathy, and how VR is being used for empathy creation.
- Chapter 3 details the Switching Perspectives interaction, the design decisions and development of the system used for the study.
- Chapter 4 describes the methodology for the comparison study, including materials used, study design, procedure, data collection and analysis methods for collected data.
- Chapter 5 reports findings from the data, including participant, quantitative and qualitative data analyzed through statistical tests, content analysis and reflexive thematic analysis.
- Chapter 6 discusses the findings of the study, connecting quantitative and qualitative data to interpret the meaning of the results, with suggestions on using Switching Perspectives Interaction and Single-Perspective Interaction methods.
- Chapter 7 outlines the limitations of this thesis and the opportunities for future work.
- Chapter 8 concludes the thesis with a summary of the work and contributions.

Chapter 2

Related Work

In this chapter, I present an overview of the literature and recent work around VR and user experience research and design (UXRD), showing the importance of VR in user research, specifically for empathizing with and understanding users. First, I introduce how VR is used as a tool in user research and design, where its usage excels, and where it's under studied as an empathy tool (Section 2.1). I then discuss what empathy is in UX research and design, comparing it to how VR is currently being used to foster empathy (Section 2.2). I further discuss the aspects of VR that are advantageous in facilitating understanding of others and empathy creation, including embodiment and perspective-taking with the possible use cases of VR for empathizing. Finally, I address gaps in the research where possible use cases of VR for empathizing exist, but no work has been done that explores different user perspective-taking through VR specific to UX research and design contexts (Section 2.3).

2.1 Virtual Reality as a Tool in User Experience Research & Design

UX research and design focus on the actual or envisioned users of a system, product, and/or technology, to consider the holistic experience. It is a process to understand how people interact with products and other people, unfolding emotions and experiences, resulting in the creation of products and systems that improve the end-users' experiences [19]. People who work towards understanding users, ideating solutions, and designing the end product are called UX researchers or designers. UX researchers and designers use a variety of tools

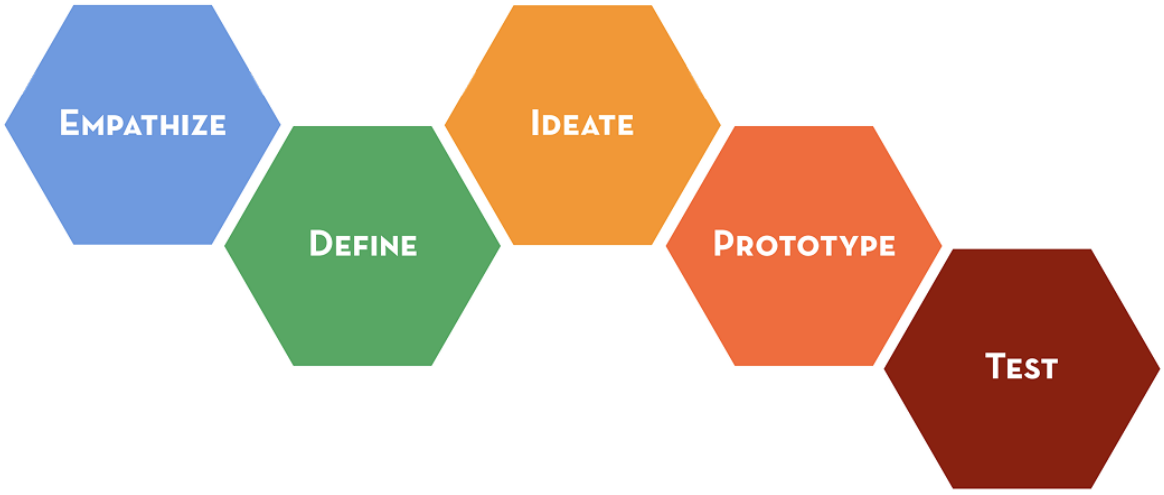


Figure 2.1: Diagram that shows five stages of design thinking from Stanford d. school [57]

to support their research and design process. From platforms to gather users for research to software for wireframing and prototyping, researchers and designers have tools supporting their design process. With the advancement of technology, it is necessary that digital tools to support researchers and designers evolve alongside them, to assist in creating appropriate, enjoyable and functional experiences [9].

Specifically, there has been a rise in the usage of VR as a proven aid to enhance *design thinking* [49], a common methodology for UX research and design. Design thinking is a strategic problem-solving process, often done in UX research as a collaborative approach in multidisciplinary teams [52]. Consisting of 5 stages, empathizing, defining, ideating, prototyping, and testing; it is a process that combines focus on the end-users with multidisciplinary collaboration, creating iterative improvements for innovative outcomes that users will interact with [50]. The first stage of empathizing starts the entire design thinking process. The problems that UX researchers and designers solve are rarely their own and they come from a particular group of people, meaning that they must make effort to understand the way users do things and the reason why [57]. Based on the information acquired during the empathizing stage, UX researchers and designers define the core problem(s), ideate and prototype solutions, and ultimately test them. Hence, the empathizing stage is the starting and central point of the process that directly affects the project outcomes. Supporting this creative process that requires learning about users to designing a solution,

VR effectively affords experiential learning [21], creative thinking [69], and the creative design process [10]. Thus, VR is recognized as an "effective tool for improving design thinking skills" [49], helping researchers and designers expand their learning and thinking within the process.

In the following subsections, I will further discuss how VR is used as a tool or how it shows potential in being a tool for UX research and design. The first section examines the advantages of VR as a design and prototyping tool, emphasizing its usage in the second half of the design thinking process (subsection 2.1.1). The second section reviews how VR can be used as a communication and collaboration tool, supporting the entire design process between researchers, designers and stakeholders (subsection 2.1.2). The third section shows how VR can be used as a testing, evaluation and validation tool for prototypes and solutions (subsection 2.1.3). Lastly, I discuss the current state of VR being used as a tool to empathize with user stories and define problems (subsection 2.1.4).

2.1.1 VR as a Designing, Ideating, and Prototyping Tool

While usage of VR in UX processes is emerging, recent work points to its utility as a tool for ideating, designing, prototyping and testing, encompassing the last half of the design thinking process [49]. As VR can provide an interactive, 3D virtual environment, it may afford beneficial use cases for 3D design, such as for the creation of physical products. Joundi et al. examined the advantages and pain points of VR as a design tool in the product design process by conducting an observatory study where participants tried a VR system with a design prompt [40]. Overall, participants were able to visualize their ideas and create desired designs in a short time frame by using a VR sketching tool. Sketching is a common method that researchers and designers use to ideate possible solutions for a problem. These positive observations show how VR is effective for envisioning shape and form ideas [40], showing its effectiveness as a sketching tool for ideating 3D designs.

VR also facilitates creativity and enhances designers' cognitive ability in the 3D solution space [71]. Houzangbe et al. compared two sketching modalities, VR and 2D interactive whiteboard, where participants were asked to do creative tasks to assess both divergent and convergent thinking [35]. Divergent thinking involves producing a "breadth of ideas" [22], where sketching serves a valuable purpose, such as being able to think of diverse ideas creatively. In contrast, convergent thinking is "a style of thinking that allows finding single solutions to a well-defined problem" [35], which represents a thinking process to refine produced ideas. The study shows that participants who used VR as a sketching tool produced more features for each idea, showing how VR can be a valuable tool to enhance divergent thinking, facilitating a type of creativity that is crucial in ideation.

Moreover, VR sketching allows researchers and designers to elevate their ability to think more intuitively in 3D space, deepening their spatial understanding as they are further engaged in the related attributes [71]. Virtual environments can support designers' imaginations, as everything is possible [39]. VR does not have a limited space, interaction, and/or abilities compared to traditional design platforms, allowing researchers and designers to explore and capture impromptu ideas creatively. Thus, VR supports an exploratory design process where researchers and designers can facilitate creative ideas, with enhanced spatial awareness, resulting in effective creation of designs, specifically in the context of 3D design, such as physical products.

While giving unlimited space for creativity to spur, VR also provides space for designers and researchers to test their prototypes in a controlled simulation. Jetter et al. highlights that VR provides an interactive space where designed ideas can be rapidly tested without the hassle of building them or setting up the testing environment in real life, saving time and equipment. Therefore, it can use fewer resources, allowing for rapid prototyping and iteration. Once the VR environment is set up, researchers and designers can reuse, replicate, and control variables, leading to successful yet valid research and design.

2.1.2 VR as Collaboration and Communication Tool

It is common to see cross-functional teams working on UX research/design projects, since diverse backgrounds, expertise, and skills are often needed to execute the projects. Smooth communication is needed between designers, researchers, developers, users, impacted stakeholders and more; it is a key aspect of the success of the project and leads to effective collaboration. With the rise of remote work, communication and collaboration among UX project teams can happen in online spaces. Here, VR offers a unique experience for team members where they can work remotely but in a shared virtual space, regardless of their physical location [65]. For example, it has been shown that VR can facilitate remote collaboration, providing more insights and coming to a conclusion in a timely manner [16]. In another study, developers preferred and were more satisfied collaborating in VR compared to an online, desktop environment [65].

In terms of UX research and design projects, many design ideas are discussed among the team, where communication-related ideas and designs are important. Close et al. compared three different remote methods to co-design, a collaborative method involving stakeholders in the design process, where successful collaboration is critical [13]. Compared to tablet-based and uploading images of paper sketches, participants found VR highly collaborative, indicating that they were focused on "designing and elaborating on the

same object together over time" [13]. This shows that VR is also helpful in convergent thinking as participants work together actively, focusing and combining efforts for a shared goal and designing a better solution.

Furthermore, VR is effective in visual communication. VR offers a 3D environment, allowing users to move around and change their points of view. As researchers and designers discuss the design ideas and detailed aspects of their proposed solutions, it is important that efficient communication regarding the visual aspects is established. In projects that involve 3D design, VR is an excellent choice to develop visual thinking as it does not limit one to be fixed in a single point of view, while thinking carefully about the "representation and visual communication of 3D shapes" [53], aiding their comprehension, which later impacts their communication positively. Overall, VR enhances diverse collaboration, ranging from simple feedback sessions to co-design sessions [16, 13] , through exceptional communication that expands one's understanding visually with playful experiences through avatars when needed.

2.1.3 VR as a Testing, Evaluation and Validation Tool

To improve the designed solutions in UX research, continuous testing, evaluations, and validations are done to refine them, understanding users again to learn how they use and feel about the solutions and prototypes [57]. VR offers a simulated environment that is easily replicable; it can speed up the development process as designers do not need to manage physical access to a real place [47]. The simulation creates a detailed, reliable understanding of the possible designs that optimize time and resources in validating design solutions [1].

When evaluating and testing a designed solution with users, often subjective measurements such as feelings towards the solution and usability are collected. Lacoche et al. examined how VR simulation can be used to evaluate an AR application, testing the user experience and usability of the system [47]. While there were no statistically significant differences, the findings still suggested that subjective criteria such as mental workload, usability, and user experience can be evaluated through VR, expanding its usage from an objective evaluation tool such as eye tracking [47].

VR can also be used to evaluate design solutions that are not application-based. Wingler et al. used VR to simulate three different designs of preoperative rooms virtually, evaluating which room better supports nursing work with the nursing faculty, the targeted users [70]. Collecting subjective to objective feedback, such as preference and visibility, the findings show that simulation-based VR evaluations can effectively combine traditional evaluation

methods, such as interviews, with objective data obtained from VR, to compare the performance of different design solutions [70]. Therefore, VR can provide richer insights and data supporting UX researchers' and designers' design thinking process, providing opportunities to develop an understanding of users further, and improve their design solutions.

2.1.4 VR as an Empathizing and Defining Tool

While VR is widely used as ideation, design, testing and communication tool, there has only been limited discussion on how it could be used in UX as an empathetic tool. Lyu et al. conducted a systematic literature review on how VR is being used in design thinking and revealed that the discussion of VR usage in the empathizing and defining stages is underestimated, although they are the critical, starting stages of design thinking [49]. VR provides new opportunities from traditional empathizing methods such as imagining to take another person's perspective or non-immersive experience; it deepens researchers' understanding and insights through visceral, sensory experiences [36]. Developing a holistic empathy for the user stories leads to the definition of the problem space [52], where researchers and designers can then carry forward into ideating, prototyping, and testing the solution. Although Zhang et al. show evidence that certain features, such as eye height and interpupillary distance, can improve a designer's empathy when viewing a virtual environment, they only focus on specific aspects within the design process, such as identifying risks and adjusting designs, rather than developing empathy early in the design process [74].

Therefore, "limited attention has been paid to the chance of bringing VR, empathy, and design research together," [37] leaving a gap in research. It is unclear what aspect of VR contributes to developing empathy in users and how effective it is, resulting in ambiguity in how VR assists the early stages of the UX process and design thinking. To reflect on this, I describe and explain what empathizing is in design thinking, and how different it is from the traditional, non-UX-process empathizing, to show the missing connection in the literature.

2.2 What is Empathy?

Conventionally, empathy is a form of social cognition where one understands and shares others' feelings and emotions [46]. There are two main categories of empathy: *affective empathy* and *cognitive empathy*. Affective empathy relates to feelings, developed through

emotional responses, while cognitive empathy represents how one understands others in context; the most optimal empathy facilitation occurs when both affective and cognitive empathy are developed in balance [29]. Additionally, when someone is empathetic, they often show prosocial behaviours such as helping, as empathy motivates them [33]. This suggests that the ability to develop empathy is an important quality for UX researchers and designers wishing to create products that are truly informed by the actual user's experiences.

Similarly, empathizing in the design thinking process aims to have a goal of understanding others, but it is not to solely feel sympathetic and develop comprehension; it is to take action, define a problem, and work towards a solution based on the understanding created [26]. Within design thinking, the empathizing stage is the initial and critical stage where understanding of users is developed. It involves "direct interaction with users" [12], where researchers/designers conduct studies with users to understand their problems, needs, wants, and more. It is a phase to synthesize knowledge, developing a diverse understanding of users and stakeholders to pinpoint the core issue [57], not a moment-in-time to empathize with others' feelings or situation. The empathizing stage helps researchers and designers to gather in-depth understanding of users, both emotionally and cognitively, allowing them to find answers to problems that even the users are unaware of [37]. It fills the gaps that simple inquiries to users will leave, creating a complete knowledge of users' needs and pain points.

2.2.1 How VR is Used for Empathizing

While VR shows potential in being an effective tool in other stages of the UX process and design thinking, such as ideating and prototyping, limited work has been done in demonstrating how VR can be used as an empathizing tool. One work by Grech et al. proposes the concept of becoming the user or observing a virtual agent acting as a user in a virtual environment, and proposes that it will result in both different types of empathy (cognitive and affective) [29]. However, no studies have been done that support this claim. It is surprising that there is limited work on the use of VR as a tool for fostering empathy in UX research and design, when VR is already known to be an effective tool in empathizing.

This raises some questions that motivate subsequent portions of this literature review:

- How is VR being used as an empathetic technology in other contexts?
- Can we leverage these features for UX research and design?

In the following subsections, I will discuss two distinct capabilities of VR that support empathy creation: embodiment (subsection 2.2.2) and perspective-taking (subsection 2.2.3). Then, I will describe specific use cases that show in what context(s) VR can be used to facilitate empathy effectively.

2.2.2 Embodiment in VR

All of the visual components that users see in a virtual environment are simulated, meaning that they are not real but digitally rendered. Even our hands that we see in VR are simulated with virtual avatar hands in non-passthrough mode, which is a mode that displays a full virtual environment, blocking camera usage to see the real world. This sensation of "being, having, and controlling a body" [42] is called the Sense of Embodiment (SoE), specifically in virtual reality. Sense of Embodiment has three properties that contribute to this phenomenon, which are: sense of self-location, sense of agency, and sense of body ownership [42].

Sense of self-location is the spatial experience of occupying inside a body; a volume of space in which one feels like they are located [31]. It is the awareness that one is inside a virtual body, distinct from the feeling of being inside the virtual environment. The sense of agency is the "experience of initiating and controlling an action" [7], the authority that one has over a body. For example, when one is grabbing items in VR, the feeling that *they* are the one grabbing, controlling the action, represents the sense of agency. It is the concept that they are responsible and 'own' their actions, expressed by the virtual body they are in charge of. Lastly, sense of body ownership is "the sense that I am the one who is undergoing an experience" [23]. It is the understanding that the body in VR is mine; the literal meaning of owning. The three properties are not independent of each other, but rather cooperate to establish SoE [31].

When the sense of embodiment is facilitated successfully through the three properties, it activates "motor-sensory and embodied cognition" [37], enriching the perceived information of the people that embody an avatar in VR. As people experience through the body they recognize as their own, the bodily experience shapes the cognitive process, creating knowledge and understanding of a specific event. As VR allows one to embody an avatar that can depict anyone from any group in the world, the embodied experience permits one to experience and enter other people's minds and bodies [3], thus creating empathy towards that specific person.

2.2.3 Perspective-Taking in VR

Another unique VR capability is perspective-taking, an act of seeing from others' viewpoints. Embodying an avatar body affords a sensation of occupying and controlling the body, while also allowing one to see the virtual environment through another person's perspective. The ability to force someone into the world of another person through a simulated environment and interaction is a powerful feature for extracting key experiences and understanding each other [64]. Thus, VR makes the well-known perspective-taking phrase "to be in another person's shoes" possible by providing the opportunity to see from a particular individual in their respective, simulated environment. As "empathy consists of the ability to view the world from another person's perspective" [62], including the emotional concerns of others, VR is an excellent technology to use to develop empathy for specific individuals. It also blurs boundaries between self and others, reducing biases in researchers and designers [36].

There are two different types of perspective-taking methods: *imagine-self* and *imagine-others*. Imagine-self is to envision how one would feel if they were in someone else's situation, while imagine-others is envisioning how that other person would feel [33]. Both perspective-taking methods promote empathy, but have notable differences in additional emotions or behaviours in conjunction with empathy. While imagine-self creates emotional responses such as personal distress, imagine-others generates prosocial behaviours [5], such as the willingness to take action and help. It has been shown that the same perspective-taking strategies apply in VR as well, where participants treat these emotions and behaviours as clues to determine if empathy has been facilitated, and what kind of perspective-taking has been used by participants. Numerous studies found an increase in prosocial behaviours towards disabled and unhoused [28, 33, 3] through immersive virtual environment and perspective-taking, or an increase in empathy scores in questionnaires that relate directly to emotions such as concerns/distress [48, 33] or affective attitudes that portray vulnerable groups' emotions [56].

There is a close connection between the types of empathy and the perspective-taking strategies. Imagine-self entails imagining oneself in another person's situation, resulting in emotional responses such as 'I feel them', which is a form of affective empathy. Cognitive empathy of 'I understand them' facilitates imagining others, when one only imagines how one might think and feel. Although these two concepts are not identical, they could provide a guideline for researchers to figure out what kind of empathy is facilitated based on the different perspectives and methods.

Although VR allows diverse perspective-taking methods, research studies often fixate on one particular avatar throughout the experience. There has been work manipulating

the eye-level of the perspective to mimic different heights of the user groups [74]. In another case, one could take the perspective of an avatar and later interact with the same avatar, being able to experience two different perspectives one after the other, or losing the perspective of the avatar one had [48]. Yin and Xiao conducted a study that compares how different points of view—first-person perspective, third-person perspective and static perspective—influence one's empathy and moral decision-making, showing the significant difference between first-person perspective to third-person and static perspectives [72]. However, limited research has been conducted that shows the creative ways of taking perspective through VR, despite its possibilities and freedom to execute what one can only imagine. Being able to experience diverse perspectives could enrich the depth of emotional and cognitive understanding, yet no work has been done to validate this interaction.

2.2.4 How Should Researchers and Designers Use VR?

Through embodiment and perspective-taking, prior works demonstrated the potential of VR being used as empathizing tool. However, these studies largely focus on exploring VR to foster empathy for specific vulnerable groups or environments, not as a tool for understanding users to address design challenges. For example, numerous works examined empathy creation and suggest positive behavioural changes [55] towards disabled [3, 28, 74], children [74, 56], unhoused [33], refugees [62], and patients [43]. While prior works use VR to emotionally align with the vulnerable groups, in UX design research, empathy functions differently. Empathizing users is the first attempt in the iterative, problem-solving, design thinking process to make connection and understand the big picture [57]. Thus, the perspective-taking and embodiment in VR need to be tailored to create persisting empathy that results in an in-depth, holistic understanding of users.

As mentioned in subsection 2.2.1, there have been works in an attempt to explore how VR can be used by researchers and designers for the empathizing stage of design thinking, specifically through modifying perspective-taking and embodiment abilities. Grech et al. interviewed designers about the challenges in empathizing with their users and proposed solutions that include manipulating different perspectives and embodiment, suggesting potential use cases of VR, explicitly for the design thinking empathizing stage [29]. The suggested solutions involve in creating a virtual representation of user environment where designers can take first-person perspective of the user or perspective of the researcher themselves observing the simulated user [29]. Grech et al. states that these solutions offers unique opportunities to develop empathy and understanding of the users, as each solution have different strengths such as obtaining holistic understanding or critically reflecting user frustrations [29], emphasizing the importance of different perspectives. Similarly, Yin and

Xiao examines how different points of view influence decision making, as different perspectives show significant differences in immersion and cognitive involvement [72]. Examining how different points of view, such as first-person-perspective, third-person-perspective, and static perspective, influence participants' empathy, their findings suggest that first-person-perspectives should be used for generating empathy [72].

Studies show that different perspectives have different influences in developing empathy and understanding, indicating how having access to multiple perspectives in VR is valuable. However, limited work has been done on how having different perspectives at the same time, *meaning being able to switch*, influences one's understanding and empathy, especially towards users for UX research and design. While different manipulations of perspective-taking are possible in VR, it remains unclear:

i) how taking the specific perspective of a user impacts specific understanding,

ii) if being able to switch from one user group's perspectives to another yields a different understanding, and

iii) when and how to use different perspective-taking interaction methods in VR to understand different user problems and needs.

For UX researchers and designers to utilize VR as an empathizing tool, further research addressing these understudied areas regarding taking different perspectives needs to be done to support their early stages of the design thinking process better.

2.3 Summary

The related works describe how VR is being used as a tool in UX research and design, discussing what empathy is, what aspects of VR facilitate empathy and its specific use cases. After reviewing the literature, I identified the following gaps that are addressed in this thesis:

Gap 1. Lack of research on VR as empathizing tool in UX research and design, when VR is optimal tool for understanding users.

Addressed in: Chapter 4, where I propose a study to investigate VR as a empathizing tool for UX research and desing.

Gap 2. No research shows the impact of being able to see from different user perspectives on empathy creation for UX research and design.

Addressed in: Chapter 4, where I propose a study to compare switching perspectives to two single perspectives in generating empathy and understanding users.

Gap 3. Limited manipulation in perspective-taking are done, not fully leveraging the capabilities of VR to explore how technology can enhance one's empathy on others.

Addressed in: Chapter 3, where I design a switching perspective interaction to show a possible perspective-taking manipulation in VR.

Chapter 3

Switching Perspectives Interaction Method

I designed an interaction method to switch perspectives in VR to conduct a study that compares this to a single perspective interaction method. Participants will engage in switching perspective interaction method within a virtual environment that shows a possible user scenario for them to observe. I implemented the scenario and interfaces for different perspectives using Unity, which is widely used for VR and AR development. Unity was set up and configured with Meta Quest 2 in developer mode, allowing real-time testing. Here, I explain the process of building a Unity prototype and creating a scenario for this thesis.

3.1 Scenario

I created a scenario for the experiment that describes a user problem where two different users contribute to the problem space equally, so that participants can observe and complete their tasks.

I needed a user scenario that involves:

1. Two different user groups that serve the roles of two different users
2. A problem area involves an environment or technology that needs design solutions.

Initially, I thought of creating a scenario that involves a technological failure, as UX research and problems often involve technological problems. Therefore, I first created a

meeting scenario with a smartboard interface, where the first user is directly using the interface with technical issues, and the second user is in a position to observe the first user and prompt the first user to use the interface. This scenario hopes to have two different groups, first and second perspectives, representing direct and indirect users of a technology that needs to be solved through UX research. However, this scenario faces some problems as it will be hard to control the same amount of interaction that each user groups have, confounds in the distance between the users to the main technology under investigation, with confusing terminology in the first and second perspectives.

After discussion and brainstorming, I then chose an emergency room for the scenario as:

1. A clearer use case for using VR for understanding users.
2. There is a clear user group: patients and medical staff, who would be directly and indirectly involved in each other's issues.
3. Controlled, consistent interaction for all groups.

A hospital environment was chosen as it is hard to gain access to and replicate for research in real life, making it an environment that would benefit from a virtual representation. In particular, the emergency room was selected to be shown through VR, as users can focus on non-serious events, such as long wait times, compared to surgery rooms. The patients and medical staff in the emergency room were chosen as the two users from whom participants could take the perspective. Here, the role of the user shapes the two distinctive user perspectives, representing two groups of users of the emergency room. The two different user perspectives allow both user groups to be in the same emergency room environment, observing the same story without confounds, as the user problem is about the frustration within the chaotic emergency room from different avatars, not a fixed-location technology where interaction may vary. The two different roles enable participants to explore different user groups' problems and needs, as well as narrow down the scope to define a single problem; a good indication on which user groups' frustrations participants empathized and understood more in-depth.

The virtual environment of an emergency room consists of a waiting room, a treatment room and a reception desk. Avatars with specific roles as patients are mostly located in the waiting room, with some on the hospital beds in the treatment room. Similarly, avatars with roles as medical staff, nurses, doctors and receptionists are located in the treatment room or near the reception desk. Based on the specific frustration points, some

Order	Frustration	User	Location
1	Wait time complaint	Patient	Patient
2	Emergency room bottleneck	Medical Staff	Patient
3	Filling out forms	Patient	Medical Staff
4	Confusion in file organization	Medical Staff	Medical Staff
5	Missing patient on list	Both	Patient
6	Short staff issue	Medical Staff	Medical Staff
7	Technological issue	Medical Staff	Medical Staff
8	Missing patient on list	Both	Patient
9	Lack of information in discharge process	Patient	Patient
10	Deteriorating patient	Patient	Patient

Table 3.1: List of user frustrations in order of location

avatars moved around the virtual environment, showing the chaotic atmosphere of the emergency room, going back and forth to talk to one another. The patient avatar and medical staff avatar that the user will take perspective share the same z coordinate in the virtual environment, located on the same side of the emergency room, side by side, but in different areas. The patient avatar is located in the waiting room area, seated on the hospital bench chair. The medical staff avatar is located in the reception desk, near the patient room area. This setup allows both perspectives to intake the same visual information with no limited view due to the location of the avatars. Figure 3.1 shows the virtual environment set up that participants saw.

In total, 9 frustrations are shown in the scenario: four patient frustrations, four medical staff frustrations, and one frustration that encompasses both users. I decided to have 9 frustration points in total to have an equal amount of user problems from both groups and one clear overlapping problem suggesting the connection between the groups, but also to ensure that the scenario is long enough for participants to adjust and observe. Common frustration points such as long waiting time, lack of guidance, poor communication, short-staffed, and organizational challenges [27, 11] are shown through virtual avatars' dialogues and motion. The location where the dialogues are exchanged in the virtual emergency room mostly corresponds to the main group of users who feel the frustration. For example, complaints about filling out forms for admittance or long wait times are patient-related frustrations and, therefore, occurred in the waiting room area. Likewise, medical staff-related frustration, such as malfunction of technological equipment, lack of file organization, is discussed in the treatment room, near the reception desk.

However, one frustration from each user is deliberately placed in the opposite location



Medical Staff Area: Treatment Room and Reception Desk



Patient Area: Waiting Room



Medical Staff and Patient Areas are Connected



Medical Staff and Patient Avatars That Participants Take the Perspective Of, Located in the Centre

Figure 3.1: VR Environment that shows the virtual emergency room, showing where two users, medical staff and a patient are located. The third image on the bottom left shows where the medical staff and the patient avatar that participants take on are located, behind the desk and sitting on the waiting bench.

to where the respective avatars are usually situated, to balance out where the frustration occurs in the virtual environment. I made this design decision to ensure that not all patient frustration occurs in the patient room, and not all medical staff frustration occurs near the reception desk or treatment room, balancing out the spatial distribution while contextually believable. I counterbalanced the order of the participants so that it alternates one after another, but due to the avatar placement, the last half of the scenario alternates in pairs. Table 3.1 shows the order of the frustration with user groups and the location within the virtual environment. There are 9 frustrations in total, but the 'Missing patient on list frustration' occurs twice to balance out the time taken to communicate the frustration, as it is a shorter instance compared to others.

3.2 Prototype

The switching perspective interaction allows participants to switch from one user group to another, from medical staff to patient and from patient to medical staff. In this section, I outline the components of switching perspective interaction.

3.2.1 Realistic Avatars

For all the avatars that participants will see, including the avatar they will take the perspective of in the virtual environment, I decided to use avatars with realistic human features. Although studies show that the different realism of the avatars in the VR does not have significant differences in empathy responses [34], people prefer realistic avatars compared to other types of avatars, such as cartoon avatars and found it enjoyable [20]. Therefore, I decided to use Mixamo avatar, a free animated 3D avatar from Adobe [2] and Unity Assets that consists of realistic medical staff avatars, both not cartoon-styled but realistic avatars. I used an avatar that wears masks, scrubs and scrub caps to visualize a medical staff avatar that participants will take the perspective of. For the patient, an avatar with casual clothing was used. Any character/avatar can take the role of a patient, but I decided to select an avatar without a specific type of clothing that hints at another job, so that it does not create assumptions about the avatar they are taking perspective.

3.2.2 Androgynous Hands for User Avatars

The hands that participants will control were androgynous hands, not depicting a certain gender. Schwind et al. reveal that if there is a mismatch in the gender of the avatar's hands in VR, people feel eeriness, especially impacting females' likability of the avatar's hands. Thus, androgynous hands that do not represent a particular gender were used for the interaction as shown in Figure 3.2. Although the character participants are portrayed with male and female genders, the hands are both androgynous. Out of all avatars' body parts, participants will mostly see the hands, meaning having androgynous hands was crucial to limit any errors.

3.2.3 Upper Body Controlled by the User

By using a Mixamo avatar that has a bone structure, the VR body was set up so that participants could control the upper body of the avatar as they were seated during the ex-



Figure 3.2: Androgynous hands in the virtual environment.

periment. Inverse kinematic (IK) control was used with the XRI interaction toolkit within the Unity software so that the avatar's movement matches the participants' movement, giving the sense of control and agency. To control variables such as the location of the avatar and the level of interaction, I had participants be seated throughout the scenario.

3.2.4 Displaying Different Perspectives

The component 'Main Camera' renders the visuals to what the users of the technology (participants) will see. To display different perspectives, the Main Camera must be manipulated so that it seems like it switches perspectives back and forth. The camera is located at the headbone structure of the Mixamo avatar that was used for the project. Two cameras were placed slightly in front of the bone to ensure that the camera was not inside the avatar, which would show the inside of the avatar's body. One camera is disabled at the start, while the other one is active, only showing one perspective at a time. A C# script controlled the camera and the avatar body that the participant would be taking, with a 1.5-second fade-in/out transition that indicates that one is switching perspective. The Figure 3.3 shows what participants will see when they press the button on the controller to switch perspectives.



Medical Staff Perspective



Fade-in Effect for Switching Perspectives



Black Screen that Indicate Perspective Switching



Fade-out Effect for Switching Perspectives



Patient Perspective

Figure 3.3: Switching perspective interaction that participants see.

Chapter 4

Methods

The main goal of the thesis is to introduce switching perspective interaction to observe scenarios, and compare it to two single perspective interactions for understanding users. In this chapter, I describe the between-participant, mixed-methods user study design that aims to investigate the above goal, which gathers data about embodiment, change in empathy, identified user problems/needs, ideated solutions and insights on the interaction methods. I state the hypotheses, explaining the use of selected materials, and conclude with the chosen analysis methods for quantitative and qualitative data collected.

4.1 Hypotheses

To answer the research questions, the following hypotheses are made based on the literature, personal understanding of VR, empathy, and UX research that:

H1: Switching perspective condition will result in less embodiment compared to medical staff and patient perspective conditions.

H2: Switching perspective will facilitate more empathy towards both groups compared to medical staff and patient perspective conditions.

H3: Participants in the patient condition will notice more patient-related problems, participants in the medical staff condition will notice more medical staff-related problems, and participants in the switching perspectives condition will notice both user problems and environmental factors leading to user problems.

H4: Participants in the patient condition will ideate more patient-related solutions, participants in the medical Staff condition will ideate more medical staff-related solutions,

and participants in the switching perspectives condition will ideate both user-related solutions and environmental solutions.

4.2 Materials

Some questionnaires used in the study are validated, while some are designed specifically to answer the research question and reveal if hypotheses can be supported. I describe the questionnaire used and explain why they are used in the following section. Furthermore, I describe additional materials used for the experimental setup.

4.2.1 Self-Reported Validated Questionnaires

Numerous studies utilize the Interpersonal Reactivity Index (IRI) questionnaire to check that there are no significant differences in participants' empathy level throughout the different conditions [33, 3, 28]. Often used as a pretest, the IRI questionnaire is a 5-point Likert scale ranging from "Does not describe me very well" to "Does describe me very well." It has 4 subscales: perspective-taking, fantasy, empathic concern, and personal distress, with 28 items [15]. As shown in the subscale, it captures both perspective-taking and emotion-related empathy. The IRI questionnaire can be administered before and after the task to see the change in empathy of participants after the VR task [59]. Because of this, the study will also conduct pre-tests and post-tests using the IRI questionnaire to measure empathy, the dependent variable of the research.

Additionally, the Avatar Embodiment Questionnaire (AEQ) is used to measure the embodiment of the avatar in VR [54]. It is a 7-point Likert Scale questionnaire ranging from 'Strongly disagree' to 'Strongly agree' that is converted to numeric values 1 to 7, with 4 subscales, Appearance, Response, Ownership, and Multi-sensory, which are used to achieve an embodiment score. As embodiment influences one's empathy, it is necessary to administer it right after the VR experience to assess if there is a difference in embodiment across the condition, which could indicate the difference in empathy facilitation.

4.2.2 Designed Questionnaire

Some questionnaires were created to fill in the gaps in measuring empathy and related behaviours. There is a limit to how much a validated questionnaire can measure empathy, as

it does not specify the type of empathy or empathy in a specific context. For example, Yin and Xiao conducted a VR perspective-taking study with moral dilemmas and associated empathy, where they created their own Likert-scale questionnaire, including questions like "How much did seeing the scenario from this perspective allow you to empathize with the agents involved in the scenario?" to determine the empathy specifically related to their situation [72]. Therefore, I also created a 7-point Likert scale questionnaire to specifically measure empathy tailored to the UX research/design context, with the aim of revealing the type of empathy fostered after the VR scenario exposure. To assess affective empathy, I formulated phrases such as "I feel user frustration" and "It was easy to feel connected to the situations and user stories presented in the emergency rooms scenario" that focus on the emotional feeling. For cognitive empathy, I created statements such as "I understand user frustration" and "It was easy to understand the situations and user stories presented in the emergency room scenario," which focus on contextual understanding of the situation and frustrations. In total, there were 9 statements in one questionnaire where participants chose on a scale of 'Strongly Disagree to' to 'Strongly Agree.' The designed questionnaire demonstrated good internal consistency reliability, with Cronbach's alpha of 0.829 (95% CI [.71, .91]).

The purpose of this research is to investigate the role of different perspectives in VR in understanding user problems and needs in a UX research/design context. Thus, I wanted to investigate if a particular perspective influences one to notice certain types of user problems more than others (for example, noticing more patient-related frustrations than those of medical staff), providing some indication of what kinds of 'others' understanding and empathy facilitates. I created an open-ended questionnaire asking users to list down user problems or needs, including questions like: "Based on the scenario you experienced, if you were asked to identify a specific area or problem within the emergency room to improve through research or design, what would you focus on, and why?"

Furthermore, the act of ideating a solution to solve user problems and meet their needs is a prosocial behaviour, suggesting cognitive empathy. I wanted to capture this behaviour as it shows a clear connection between empathizing and ideating stages of UX design and research. Therefore, the last question on the open-ended questionnaire was regarding the ideating solution: "After experiencing the scenario from the user's perspective, what solutions can you propose/ideate to address the problems you noticed? Feel free to list, describe, or sketch as many ideas as you like."



Figure 4.1: Meta Quest 2 headsets and controllers

4.2.3 Experimental Set Up

Meta Quest 2 shown in Figure 4.1 was used for the study, which was connected via USB-C cable to the Windows laptop to play the developed VR scenario with the device. The video and audio were recorded through an iPhone 15, capturing participants' behaviours and dialogues. Embedded screen capture software from the Windows laptop was used to record the screen that participants see in VR. Participants used a separate laptop to fill out questionnaires and to see the videos of two other interaction methods they had not experienced.

4.3 Study Design

The study is a between-participant, mixed-methods study with three conditions:

1. Switching Perspectives: Participants are able switch perspectives from medical staff to patients and vice versa by pressing A button on the controllers whenever they wish to. There are two sub-conditions within Switching Perspectives; one starts the experience with the medical staff's perspective while the other starts with the patient's perspective, balancing out the starting perspective of this condition.

2. Medical Staff Perspective: Participants are only able to see and experience the scenario from the medical staff's perspective.

3. Patient Perspective: Participants are only able to see and experience the scenario from the patient's perspective.

Participants will experience one of the conditions through VR, and the order has been counterbalanced. All participants will experience the same user scenario, with a task to understand the user and find their needs, problems, and experiences. Following the VR experience, participants completed questionnaires, and a semi-structured interview was conducted, asking participants about their experience in VR, reasoning why they selected certain user problems to tackle, thoughts on the different perspective interactions they did not get to experience, etc.

4.4 Recruitment

Participants were recruited through posters and emails around the University of Waterloo that detailed the following eligibility criteria:

- 18-64 years old.
- Have working knowledge of UX design and research.
- No history of experiencing severe cybersickness or medical conditions that make them susceptible to cybersickness or poor experiences when using VR (ex., vertigo, sensory impairments).
- Normal/Corrected-to-normal vision

As the work focuses on how to use VR as a tool to assist UX research and design, it was necessary and important for participants to have a working knowledge of UX design and research to understand the task and questions asked regarding the user needs and problems. Participants were asked to fill out a questionnaire that included a question asking about their UX research and design experience before the task to assess if they met the eligibility criteria later in the analysis.

Additionally, it was critical to exclude participants with a history of severe cybersickness and/or related medical conditions, as it can negatively impact their experience in VR. Participants should also have normal/corrected-to-normal vision for similar reasoning; they should be able to see the virtual environment clearly with HMD and fully observe and understand the context. The eligibility criteria were also on the information letter, and participants were asked verbally before starting the study to ensure that all participants met the criteria to participate, without additional questionnaires that screened them.

4.5 Procedure

Once the participant seeks out interest and schedules a study session through Calendly, an information letter detailing the experiment, including the disclaimer that the scenario will depict an emergency room with patients and medical staff. It is to inform them that there are no depictions of graphic medical procedures, blood, or serious injuries, and rather the focus is on understanding user experiences in the emergency, rather than portraying medical trauma; ensuring that participants are aware and are not uncomfortable by surprising content when the study begins.

When participant arrived at the study site, they were asked to fill out the consent form, followed by a demographic and background questionnaire asking about their prior experience in UX research/design. Then, the pre-test IRI questionnaire is administered. Once the participant had filled out all the questionnaires that needed to be completed before the VR experience, they were then verbally informed what their task would be.

Participants experienced one of the conditions (switching perspectives, medical staff, and patient) through VR, in a seated, stationary position. They were informed that they would observe and experience an approximately 8-minute-long user scenario as if they were a UX researcher/designer, with a task to understand the user and find their needs, problems, and experiences. Participants were asked to put on the Meta Quest 2 headsets and adjust them until they could clearly see the environment. Assistance was provided upon request or as needed. There were no practice tasks, and participants were asked to hold on to the controllers for their virtual hands throughout the scenario.

Once the scenario ended, participants first filled out the avatar embodiment questionnaire, followed by IRI, Likert-scale, and an open-ended questionnaire. A semi-structured interview was conducted afterwards. They were interviewed about their experiences, the key frustrations they identified and ideated solutions for further insights. Finally, two short videos of the interaction method/condition that they did not get to experience were shown to them, such as seeing the patient and medical staff perspectives if participants were in a switching perspective condition. Finally, interview questions regarding the different perspective-taking methods were asked.

4.6 Data Collection

Consent to participate was collected through the online survey platform Qualtrics[1], which also contains consent regarding being video, audio and screen-recorded, use of video recording with blurred facial features for publication, and use of direct quotes. Through Qualtrics, both quantitative and qualitative data from the questionnaire were collected, except for the last question, which asked participants to ideate solutions. Participants were given freedom to sketch ideas, and therefore, only this question was administered on paper, collecting written and sketched responses. All data are recorded and stored on Microsoft OneDrive[2], with the exception of the qualitative data collected through paper, which is stored in a locked office. Participants' data were anonymized with IDs such as P1 and P2 for reference purposes.

4.7 Analysis

This study is a mixed-methods study, which collected both quantitative and qualitative data for analysis.

4.7.1 Quantitative Data Analysis Method

For questionnaire data such as Avatar Embodiment and Likert-scale, one-way ANOVA was conducted across the three conditions. Each subscale in the Avatar Embodiment questionnaire (Appearance, Response, Ownership, and Multi-sensory) and the Embodiment score were analyzed. For designed Likert-scale questionnaire, each statement was analyzed separately to find the significance in the differences across the conditions. Although Likert-scale statements were intended to capture affective empathy, cognitive empathy, and understanding developed from perspective-taking interaction, as the questionnaire is not externally validated with unconfirmed subscales, one-way ANOVA was conducted for each statement. Levene's test and Q-Q plots are used to check assumptions. If a particular dataset does not meet the assumptions for one-way ANOVA, a non-parametric statistical test, the Kruskal-Wallis test was used. Tukey's post-hoc test was further conducted to determine which specific pairs of conditions have significant differences and if there was statistical significance through one-way ANOVA.

[1]https://www.qualtrics.com/
[2]https://onedrive.live.com/

One-way ANOVA was also conducted on the pre-condition data from the Interpersonal Reactivity Index (IRI) questionnaire to check if the empathy level between the three condition groups has no significant differences. Additionally, a 2-way mixed effects ANOVA with orthogonal contrast was done to compare the change in IRI scores by subtracting pre-condition scores from post-condition scores.

There were two participants who left one of the IRI scores blank in their answers. Participants have the freedom to not answer any questions during the study session, but one missing score will impact the result significantly, as IRI subscale scores are calculated by sum, not the mean. To mitigate the missing data, data imputation was used to replace the missing value with an appropriate value following the guidelines proposed by Jäger et al. [41]. The two missing IRI scores from two different subscales were completely random compared to any other value, which is considered as "Missing Completely at Random" [41] in the missingness pattern. For the Missing Completely at Random (MCAR) pattern, mean/median imputation, a simple method should be used. Therefore, the two missing values were inputted by taking the average score of the impacted subscales. The results from this analysis are presented in Section 5.2.

4.7.2 Qualitative Data Analysis Method

Qualitative data from the questionnaires and interviews were analyzed using two methods: content analysis and reflexive thematic analysis (RTA).

Content analysis was used to quantify the qualitative data in the questionnaire, which allows researchers to identify patterns and trends [45]. Following Bengtsson's framework in conducting content analysis, I decontextualize data to identify the meaning of data and code, followed by recontextualization to examine if all data were coded accordingly, and then categorize the coded data to provide the results [6]. Qualitative data, such as the problems, needs, core area for solution, and design solutions that participants identified and ideated, were counted through inductive coding to directly compare which user group or factors were mentioned by participants across the three different conditions, indicating the users to whom they were more empathetic. For each data point, the type of user or area that it pertained to, or centred around, was coded, such as patient, medical staff, environment, etc., which were iterated and refined.

To describe and develop the themes from the content analysis findings, reflexive thematic analysis [8] was used. Emergent themes from the reflexive thematic analysis (RTA) complement the quantitative results of content analysis, explaining how and why these occur. Other qualitative data that is not analyzed through content analysis was analyzed

through this method, including interview data. Starting with familiarization with data, I used the inductive coding approach to generate initial codes, followed by constructing themes. The themes were reviewed, developed, defined and reported, revealing further insights into the content analysis and answering the research questions. The results are presented in Section 5.3 onwards.

Chapter 5

Results

In this chapter, I will discuss the findings from the questionnaire and interview data collected from the between-participant study I conducted. First, data about the participants' demographics and prior experience is shown with an explanation of the removed participants' data. Next, the quantitative analysis will show statistical test results for the AEQ, the IRI questionnaire, and the Likert-scale questionnaire. In the following qualitative analysis section, findings from the content analysis and reflexive thematic analysis are presented.

5.1 Participants

I aimed to recruit 30 participants, 10 for each condition, since this study is mixed method, focusing on the participants' experience in-depth. However, I recruited 36 participants in total as 6 participants' data should not be included for the following reasons to preserve the quality of data:

- Did not have adequate knowledge on UX research and design to be considered as an eligible participant, and/or,
- Misunderstood the instructions and questionnaire questions, resulting in task failure.

Through questionnaire answers and interviews, some participants showed incorrect knowledge of what UX research and design are, which could have impacted their comprehension of tasks. A common misconception was referring to user interface or usability,

Cases	Sum of Squares	df	Mean Square	F	P	η_p^2
Condition	8.728	2	4.364	2.529	0.098	0.158
Residuals	46.589	27	1.726			

Table 5.1: One-way ANOVA result for Appearance (AEQ)

which resulted in them analyzing the VR system's usability instead of understanding the user scenario. Although the instructions were clearly described, numerous times if needed, with opportunities to ask questions before the task, some participants misunderstood the assignment, and their data had to be excluded.

Participants' ages ranged from 19 to 33 (M = 23, SD = 3.768), consisting of 18 women, 11 men, and 1 did not disclose information on gender. There was a wide range of experience in UX research/design among the participants, from participants knowing only the basic concept through other means, such as HTML/CSS, to participants who are professionals in the field, working as a UX researcher/designer.

5.2 Quantitative Results

This section shows the statistical tests' results for the quantitative data from the questionnaires. For all quantitative data analysis, JASP was used to find the statistical significance between the conditions.

5.2.1 Avatar Embodiment Questionnaire

The Avatar Embodiment Questionnaire (AEQ) has 4 subscales that contribute to the overall embodiment level: Appearance, Response, Ownership, and Multi-sensory. The average score of the subscales was taken to acquire the overall embodiment score. I conducted a One-Way ANOVA for each item across the three conditions, followed by Tukey's post-hoc test to determine significant differences between the medical and patient conditions for the Ownership subscale. Figure 5.1 shows the results from the one-way ANOVA and the distribution of data through boxplots.

The result from the one-way ANOVA revealed that there is a statistical significance between the conditions only for the Ownership subscale, as shown in Table 5.1, Table 5.2, Table 5.3, Table 5.4, and Table 5.5. There was a statistical significance for Ownership subscale ($F(2, 27) = 3.589$, $p = .041$, $\eta_p^2 = 0.210$), between the medical staff and patient

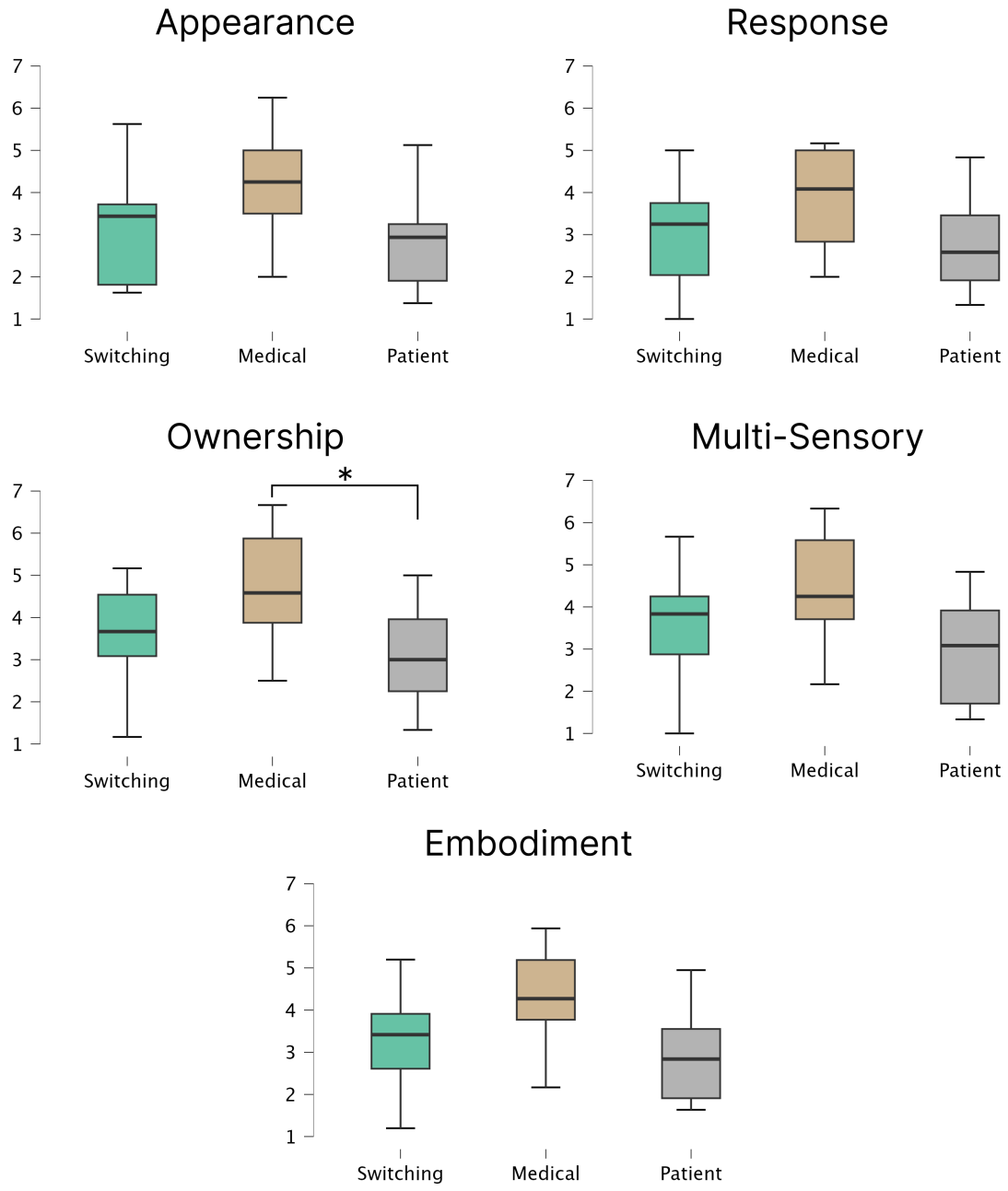


Figure 5.1: Boxplots that show results from the Avatar Embodiment Questionnaire (AEQ). The asterisks (*) denote statistical significance of $p < .05$.

Cases	Sum of Squares	df	Mean Square	F	P	η_p^2
Condition	5.813	2	2.906	1.857	0.176	0.121
Residuals	42.269	27	1.566			

Table 5.2: One-way ANOVA result for Response (AEQ)

Cases	Sum of Squares	df	Mean Square	F	P	η_p^2
Condition	11.785	2	5.893	3.589	0.041*	0.210
Residuals	44.331	27	1.642			

Table 5.3: One-way ANOVA result for Ownership (AEQ)

Post-hoc Comparison

		Mean Difference	SE	t	p_{tukey}
Switching	Medical	-1.033	0.573	-1.803	0.188
	Patient	0.467	0.573	0.814	0.697
Medical	Patient	1.500	0.573	2.618	0.037*

Table 5.4: Post-hoc test result for Ownership (AEQ)

Cases	Sum of Squares	df	Mean Square	F	P	η_p^2
Condition	11.057	2	5.529	3.092	0.062	0.186
Residuals	48.272	27	1.788			

Table 5.5: One-way ANOVA result for Multi-Sensory (AEQ)

Cases	Sum of Squares	df	Mean Square	F	P	η_p^2
Condition	8.728	2	4.560	3.113	0.061	0.187
Residuals	46.589	27	1.465			

Table 5.6: One-way ANOVA result for Embodiment (AEQ)

conditions ($p = .037$). The analysis shows that the Appearance subscale is statistically not significant ($F(2, 27) = 2.529$, $p = .098$, $\eta_p^2 = 0.158$). The Response subscale also shows no statistical significance ($F(2, 27) = 1.857$, $p = .176$, $\eta_p^2 = 0.121$). The Multi-Sensory subscale shows no statistical significance ($F(2, 27) = 3.092$, $p = .062$, $\eta_p^2 = 0.186$). Lastly, one-way ANOVA revealed no statistical significance in the overall embodiment score ($F(2, 27) = 3.113$, $p = .061$, $\eta_p^2 = 0.187$). Although it is not statistically significant at the level $p < .05$, the Appearance, Multi-Sensory and Embodiment scores are close to being statistically significant (0.098, 0.062, and 0.061, respectively). Therefore, H1 is not supported as there is no significant difference in avatar embodiment for the *switching perspectives* condition compared to the other conditions (medical, patient). The overall trend shows that medical staff condition scores the highest, followed by switching perspectives and patient conditions.

5.2.2 IRI Questionnaire

One-way ANOVA showed that there is no statistical difference in participant's empathy level on any subscales between the conditions prior to the VR scenario [Fantasy: ($F(2, 27) = 0.911$, $p = .414$, $\eta_p^2 = 0.063$) Empathic Concern: ($F(2, 27) = 0.079$, $p = .924$, $\eta_p^2 = 0.006$) Perspective Taking: ($F(2, 27) = 0.331$, $p = .721$, $\eta_p^2 = 0.024$), Personal Distress: ($F(2, 27) = 0.009$, $p = .992$, $\eta_p^2 = 0.0006$)]. These results show that the conditions were counterbalanced, as there is no significant relationship between the conditions, meaning participants' empathy levels were randomized successfully.

2-way mixed effects ANOVA was conducted with *time* (pre- and post-) as a within-participant factor, and the between-participant factors of *the different VR interaction methods for each IRI subscale* (Fantasy/FS, Empathic Concern/EC, Perspective Taking/PC, and Personal Distress/PD). Orthogonal contrasts were used to compare each different condition, where:

A: Medical Staff vs Patient;

B: Switching Perspectives vs Patient;

C: Switching Perspectives vs Medical Staff;

D: Switching Perspectives Medical to Patient (M-P) vs Switching Perspectives Patient to Medical (P-M).

Condition	Time	A	B	C	D
Switching M-P	Pre	0	-1	1	1
Switching P-M		0	-1	1	1
Medical Staff		1	0	-2	0
Patient		-1	-2	0	0
Switching M-P	Post	0	1	-1	-1
Switching P-M		0	1	-1	-1
Medical Staff		-1	0	2	0
Patient		1	-2	0	0

Table 5.7: Table for orthogonal contrast for two-way mixed effects ANOVA for IRI questionnaire data

Subscale	Comparison	t(26)	p	Cohen's d
Fantasy	A	1.157	0.258	0.631
	B	-15.299	$< .001$ **	-19.352
	C	-0.757	0.459	-0.825
	D	-0.504	0.619	0.619
Empathic Concern	A	-0.168	0.868	0.868
	B	-14.880	$< .001$**	-18.822
	C	1.231	0.229	0.979
	D	0.317	0.754	0.178
Perspective Taking	A	0.136	0.893	0.048
	B	-13.494	$< .001$**	-17.068
	C	-0.203	0.840	-0.144
	D	-1.150	0.261	-0.577
Personal Distress	A	-1.174	0.251	-0.361
	B	-7.500	$< .001$**	-9.487
	C	0.528	0.602	0.325
	D	0.332	0.743	0.144

Table 5.8: Result of 2-way mixed-effect ANOVA for each subscale in IRI questionnaire

As shown in Table 5.7, the contrast coefficients are balanced accordingly to account for the number of participants in the different conditions. Table 5.8 shows the analysis result of each subscale and each comparison group.

The change in mean of each subscale for each condition are shown through Figure 5.2. The fantasy score increased after the VR scenario for all conditions, while Empathic Concern, Perspective Taking, and Personal Distress showed both increases and decreases in respective scores. The Empathic Concern score increased for all conditions except for the medical staff, which decreased. The Perspective Taking score increased for medical staff and patient, but decreased in switching M-P and stayed consistent in switching P-M. Lastly, Personal Distress decreased for all conditions except Medical staff, which increased.

The analysis revealed that there is a significant differences in change of scores before and after the VR scenario in comparison B, switching perspectives vs patient for all subscales [Fantasy ($t(26) = –15.299$, $p < .001$, $d = –19.352$), Empathic Concern ($t(26) = –14.880$, $p < .001$, $d = –18.822$), Perspective Taking ($t(26) = –13.494$, $p < .001$, $d = –17.068$), and Personal Distress ($t(26) = –7.500, p < .001, d = –9.487$)]. The results indicate that there is a significant change in empathy level due to the VR interaction method between *switching Perspectives* and the *patient* condition. There were no other significant differences between the comparison and the different subscales. Therefore, H2 is partially supported as Switching Perspectives facilitates more empathy in certain IRI items for only the Patient condition.

5.2.3 Likert-scale Questionnaire

One-way ANOVA revealed that there is no statistical difference between all conditions for all questions as shown in Figure 5.3. Although there is no statistical significance, results show that participants were able to feel and understand the scenario and frustration. Participants reported that they feel user frustration (*Switching Mdn = 6, Medical Mdn = 6.5, Patient Mdn = 6.5*), and understand user frustration (*Switching Mdn = 6, Medical Mdn = 6, Patient Mdn = 6*). They believed that it was easy to feel connected to situations and user stories presented in the emergency room scenario (*Switching Mdn = 7, Medical Mdn = 6, Patient Mdn = 6*), also to understand it (*Switching Mdn = 6.5, Medical Mdn = 6, Patient Mdn = 7*). Participants reported that seeing the user scenario from the perspective that they took was helpful to understand user experience (*Switching Mdn = 6.5, Medical Mdn = 6, Patient Mdn = 7*) and believed it deepened their understanding (*Switching Mdn = 6, Medical Mdn = 6.5, Patient Mdn = 7*). Participants were quite confident that they found most user needs and problems (*Switching Mdn = 5.5, Medical*

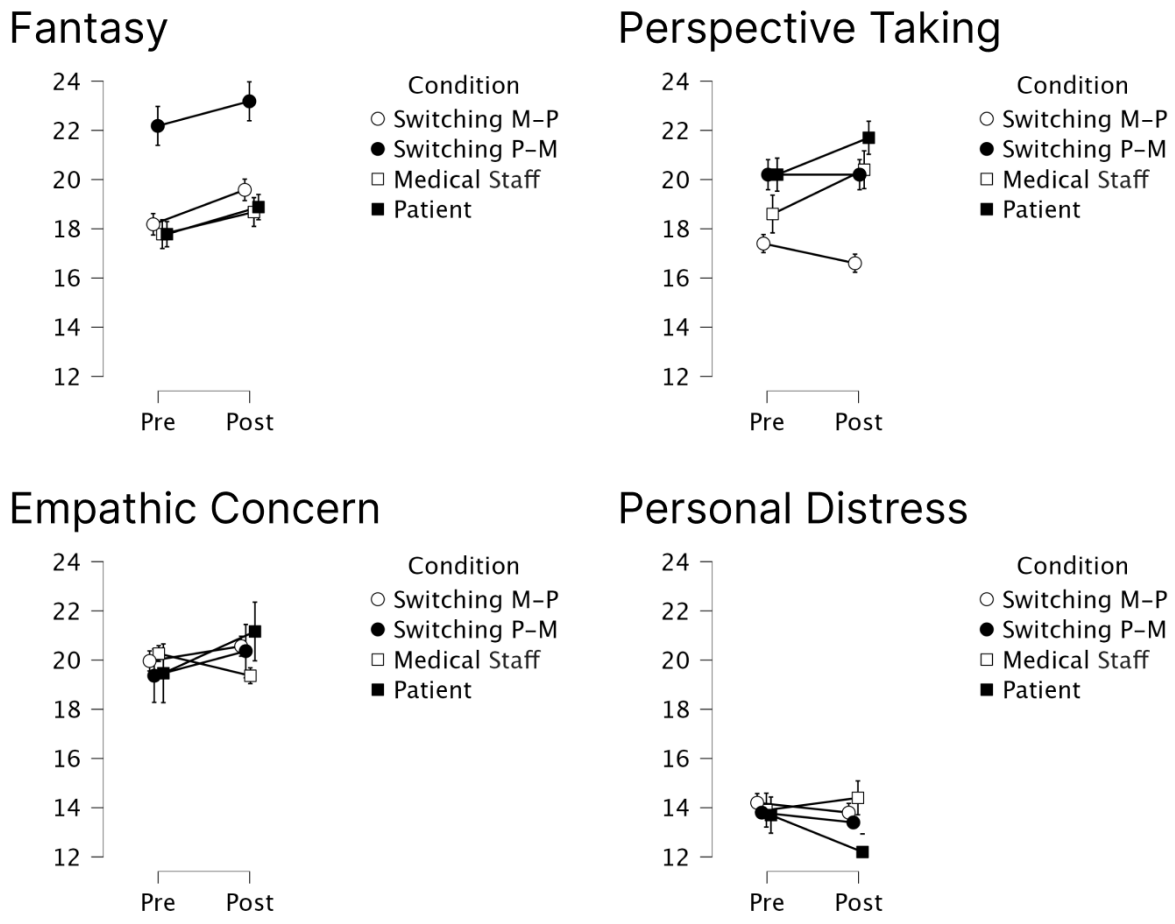


Figure 5.2: Line graph that shows change in mean value of IRI subscale score per condition with standard error

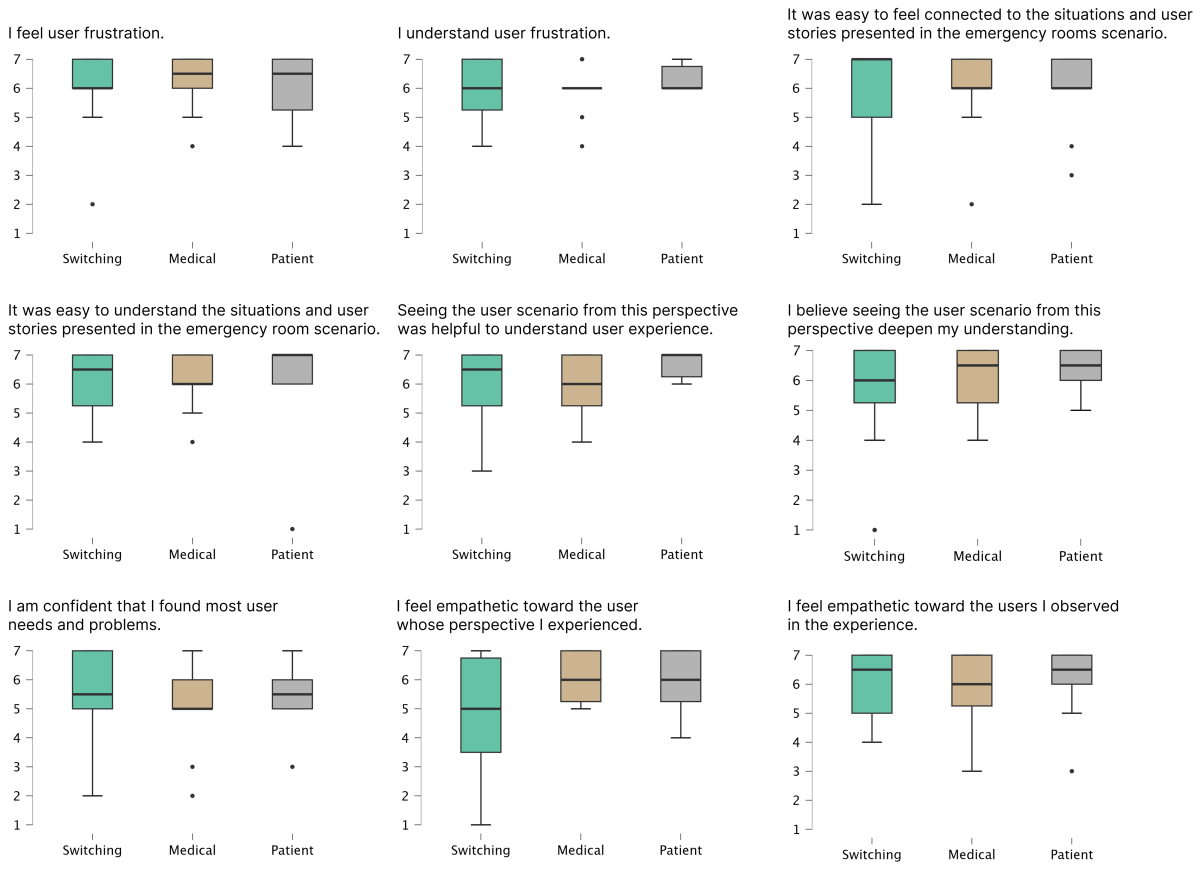


Figure 5.3: Boxplots that show 9 Likert-scale items of the conditions.

Mdn = 5, Patient Mdn = 5.5). Finally, participants felt empathetic towards users whose perspective they experienced (*Switching Mdn = 5, Medical Mdn = 6, Patient Mdn = 6*) and observed (*Switching Mdn = 6.5, Medical Mdn = 6, Patient Mdn = 6.5*).

5.2.4 Summary: Questionnaire Data

In this section, I shared results from the AEQ, IRI and Likert-Scale questionnaires, which showed the participants' avatar embodiment level, the change in empathy, and understanding of user frustration and experience. The analysis revealed that H2 is partially supported and additionally showed support/added context for H3 and H4, as empathy fa-

cilitation would assist participants in identifying user problems and ideation solutions. The results suggest that H1 is not supported. Next, I will add to the analysis by describing my use of Content Analysis to build a better understanding of where the empathy is directed, towards which user groups.

5.3 Content Analysis

I used Content Analysis following the Bengtsson's framework [6] described in subsection 4.7.2 to quantify types of user problems, user needs, core problem areas and the design solution that participants ideate. The iterated codes are listed below, including definitions and example quotes that show when certain parts of the participant's answers were counted.

Patient Problems

Problems that Patient user group face, not caused by, including delays, confusion, lack of support, etc., Example Quote: "Patients waiting in the ER are not informed about wait times." (P21)

Medical Staff Problems

Problems that the Medical Staff user group face, not caused by, missing files, technical equipment issues, short-staffed, etc., Example Quote: "Inability to look up the schedules of staff to attend to patient beds." (P30)

Environment Problem

Problem related to the hospital environment and/or room settings, including location of beds, chairs, desks, screens, etc. Example Quote: "I saw there was a screen on the top, but nothing was displaying on it." (P23)

Interrelated Problems

Problems from one group (patient, medical staff, or environment) that impact the other group. It is only counted if the participant clearly mentions the connection between groups,

and is counted separately from the patient/medical/environment problems. It does not include the connection of two different problems from the same user group, as this shows one user group problem in detail, not the relationship of two user groups, such as a lack of communication, losing files, which causes longer wait times, etc. Example quote: "Lack of communication between staff and patients." (P13)

Patient Needs

Needs from the Patient user group that are clear, resulting from the Patients, including clear instructions, efficient care, transparency in procedure, shorter wait times, etc. Example quote: "The patients - Clear instructions of what happens after triage." (P2)

Medical Staff Needs

Needs from the Medical Staff user group that are clear, resulting from the Medical Staff, including an efficient filling system, a support system for executing tasks, a better staff management system, etc. Example quote: "Better organization among the ER staff." (P29)

Environment Needs

Needs that are directly related to changing the hospital environment and/or room settings, including the location of beds, chairs, desks, screens, etc. Example Quote: "Space for [to] take break." (P27)

Interrelated Needs

Needs from one group (patient, medical staff, or environment) that influence the other group's needs. It is only counted if the participant clearly mentions the connection between user groups, and is counted separately from the patient/medical/environment needs. It does not include two separate needs from each group or one group, such as better communication, private space for patients and medical staff, medical staff needing more resources for shorter patient waiting time, etc. Example quote: "More staff to handle the large number of patients waiting ... The staff, too, would have benefited from more staff on shift to handle the large number of patients waiting." (P12)

Patient Area

One area that each participant wants to select and work towards that focuses on solving the patient problem, including patient waiting time, taking care of deteriorating patients in a timely manner, and improving the lack of information. Example quote: "I would choose to focus on how I could make sure that there is someone available to take care of patients whose conditions start to worsen." (P6)

Medical Staff Area

One area that participants want to select and work towards that focuses on solving the medical staff problem, including record-keeping, supporting staff, digitization of patient files, etc. Example quote: "Better records and queueing system to prevent lost records, prevent confusion from the staff side, and facilitate more efficient turnover." (P4)

Combined Area

One area that participants want to select and work towards that focuses on solving the patient and medical staff problem coherently. Although participants were asked to select one specific area, some participants decided to select an area that involves and clearly mentions both user groups. Therefore, one combined area is counted instead of the patient and medical staff area. Example quote: "I think I would focus on communication specifically and looking at how information is getting communicated out to everyone ... I perhaps would focus on communication between staff first and then filter that down to the patients." (P3)

Environment Area

One area that each participant wants to select and work towards is one that focuses on changing the environment of the hospital emergency room, including the alarm system, chairs, and a private and comfortable space. Example quote: "The chairs seemed too close to one another; more space could have been given while designing." (P12)

Ideated Design Solutions

Design ideas that participants ideated to provide solutions to the problems they observed in the Emergency room environment. Solutions regarding simple human issues, not designed

or vague to understand the meaning, were not counted, such as hiring more people, a specific person, or a digital file system. The total number of ideated design solutions for each participant is recorded.

Solutions for Patients

Design ideas that help patients to have a better experience, meet their needs and solve problems that center them. Example ideas are shown in Figure 5.4.

Solutions for Medical Staff

Design ideas that help Medical Staff to have a better experience, meet their needs, and solve problems that center them. Example ideas are shown in Figure 5.5.

Solutions for Environment

Design ideas that change the Environment, the emergency room, to have a better experience, meeting needs, solving problems that center them. Example ideas are shown in Figure 5.6

To note, some participants did ideate solutions that cover two or three groups (patient, medical staff, and environment). However, unlike other items that are counted, interrelated solutions were not coded for designed solutions, as participants clearly mentioned which primary group the solution is for. For example, "self-serve kiosk for patients" (P30) is coded as *Solutions for Patients* as it focuses on patients, when it can be recognized as a helpful addition to the environment. Another example was the "alert system for emergency room for friendlier environment" (P1). This is coded as *Solutions for Environment* as it directly changes the environmental setting of the problem space, but the underlying reasoning is to make patients and medical staff less stressed. There was one participant (P18) who equally emphasized both patient and medical staff in their ideated solution, which I decided to code 0.5 for *Solutions for Patients* and *Solutions for Medical Staff*, as it clearly belongs to both categories at once.

5.3.1 Identified Problems

The average of the counted identified problems in each condition is shown in Table 5.9. Participants from the *Switching Perspectives* condition reported the most Medical Staff

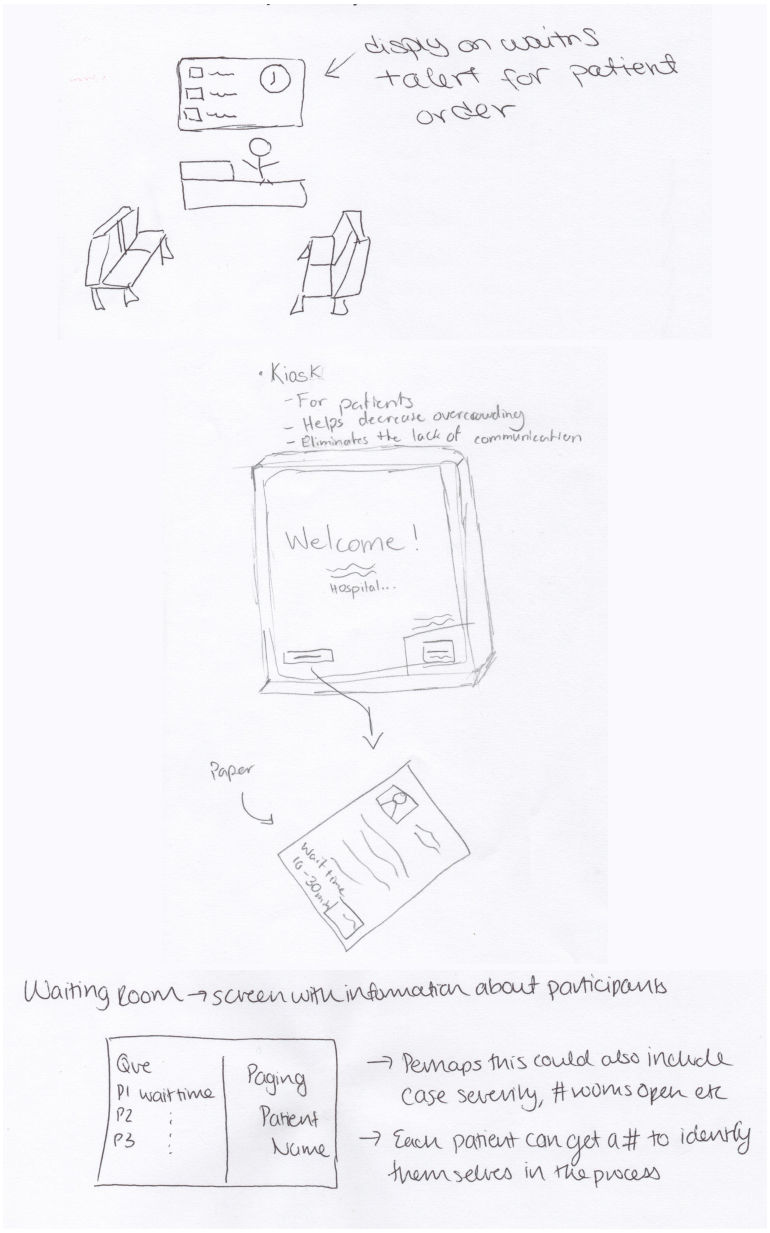


Figure 5.4: Solution for Patients that participants ideated

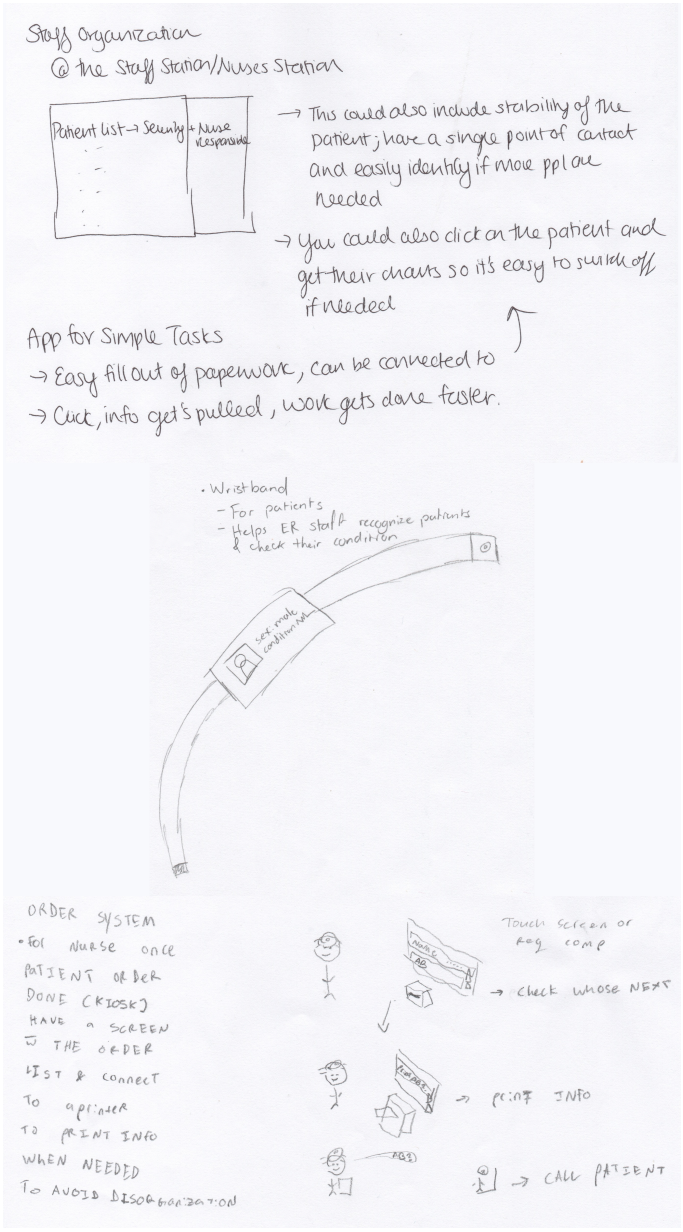


Figure 5.5: Solution for Medical Staff that participants ideated

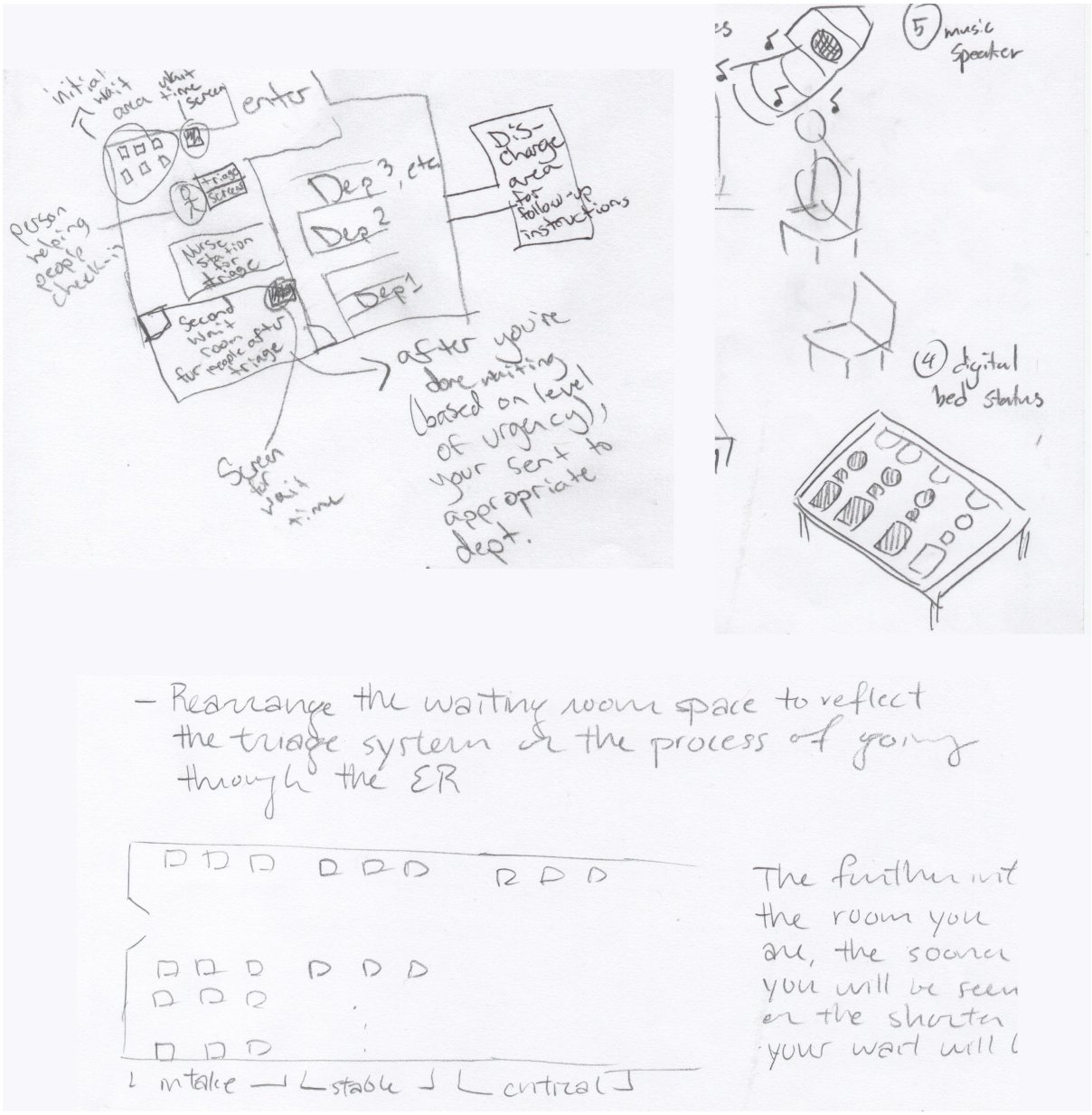


Figure 5.6: Solution for Environment that participants ideated

Conditions	Patient	Medical Staff	Environment	Interrelated
Switching Perspectives	2.9	3.5	0.2	0.9
Medical Staff	2.6	4	0.2	2.1
Patient	3.1	3.3	0.6	2.1

Table 5.9: Average number of problems participants found in each condition

Conditions	Patient	Medical Staff	Environment	Interrelated
Switching Perspectives	3.1	3.5	0.2	1.6
Medical Staff	2.1	2.8	2.8	0.2
Patient	2.4	2.5	0.5	1.8

Table 5.10: Average number of needs participants found in each condition

problems, but the lowest Environmental and Interrelated problems. Participants in the *Medical Staff* group reported the highest Medical Staff and Interrelated problems, but reported the lowest Patient and Environmental problems. Participants in the *Patient* condition reported the most Patient, Environment, and Interrelated problems while reporting the lowest Medical Staff problems. Therefore, H3 is partially supported as only the participants from the Medical Staff condition identified more Medical Staff problems. This suggests that seeing from a specific role's perspective leads individuals to identify problems faced by that role's in-group.

5.3.2 Identified Needs

The average of the counted identified needs in each condition is shown in Table 5.10. Participants from the Switching Perspectives condition reported the most Patient and Medical Staff Needs, but the least Environment Needs. Participants in the Medical Staff condition reported the most Environment Needs but the least Interrelated Needs. Lastly, Participants in the Patient condition reported the most Interrelated Problems while reporting the lowest Medical Staff Problems. The results suggest that switching perspectives allows individuals to identify more user needs than seeing from a single, fixed perspective. Future work examining how Medical Staff condition influences participants to identify the most environmental needs, but the least interrelated needs, may illuminate the differences that were not detected here.

Conditions	Patient	Medical Staff	Environment	Combined
Switching Perspectives	2	2	4	2
Medical Staff	5	4	0	1
Patient	2	3	1	4

Table 5.11: Number of identified areas to focus on by participants in each condition

5.3.3 Identified Areas to Focus

Table 5.11 shows the number of identified areas that participants wanted to focus. Each participant identified one specific area within the emergency room to improve through research or design. Participants from the Switching Perspectives condition reported the most on the Environment Area, while reporting the least on the Patient and Medical Staff Areas. Participants in the Medical Staff condition reported the most Patient and Medical Staff Areas, but reported the least Combined Area. Participants in the Patient condition reported the most Combined Problems while reporting the lowest Medical Patient and Environment Area. Although it does not directly support H3, the findings add context of relative importance to the identified problems by showing which problems participants value the most.

5.3.4 Ideated Design Solutions

The average number of ideated design solutions by participants are shown in Table 5.12. Participants from the Switching Perspectives condition reported the highest average number of ideas, 2.7 ideas, while participants in the Medical Staff and Patient conditions reported fewer, 2.1 and 2.2 ideas, respectively. Switching Perspectives condition reported the most Solutions for the Patient and Solutions for the Medical Staff. Participants from Medical Staff reported the fewest Solutions for Patient and Solutions for Environment, while reporting the most Solutions for Medical Staff. Lastly, participants from the Patient condition reported the most Solutions for Environment but the fewest Solutions for Medical Staff. Therefore, H4 is partially supported as participants in the Patient condition ideated more patient-related solutions and participants in the Medical Staff condition ideated more medical staff-related solutions.

Conditions	Patient	Medical Staff	Environment	Ideated Design Solutions
Switching Perspectives	1.2	0.9	0.6	2.7
Medical Staff	0.8	0.9	0.4	2.1
Patient	1.05	0.45	0.78	2.2

Table 5.12: Average number of design solutions participants ideated in each condition

5.3.5 Summary: Content Analysis

In this section, I shared results from Content Analysis, which showed the average number of identified problems, needs, design solutions, and the key problem area participants wish to improve. This analysis lent credence to H3 and H4 being supported. Next, I will engage further with qualitative results to build a more fulsome picture of the phenomena being studied.

5.4 Reflexive Thematic Analysis

In this section, I discuss five themes developed through Reflexive Thematic Analysis (RTA), presenting stories about the data collected through questionnaires and interviews.

5.4.1 Immersive Environment Fosters Empathy

Participants found the VR emergency room and scenario immersive, feeling like they were part of the virtual environment that depicts user stories of their problems and needs. They reacted the same way they would in real life in the simulated environment, such as wanting to move away from the sick, coughing person, blurring boundaries of the two different worlds. It even creates a personal connection to their own experience, reminding them of the times they were in a similar environment, such as hospitals, clinics, and emergency rooms in real life:

> "One thing I was impressed about was, it actually does feel very immersive, which is a reminder for me that VR does really well with immersion. Because at one point the patient coughed and my first reaction was to move away from the patient to the other perspective. Because, in real life, I get really paranoid when other people are coughing near me. So then when I did that, I realized, I'm actually immersed enough to feel." (P4)

> "It reminded me a lot of the hospital in my hometown because that hospital is extremely disorganized and like you're waiting seven hours just to be seen. So I kind of just felt I've been here before." (P17)

Although there was a limited realism visually to the virtual environment, participants felt that contextually the user story and environment were believable and real. The avatar's movement and design were not smooth and could be more hyper-realistic, but participants felt that the noise, actions, and the chaotic, stressful environment portrayed by 3D avatars and props in the virtual emergency room communicated the context of the scenario, creating emotional responses:

> "I felt like I was more in like a cartoonish place. [But] it did feel realistic though. The background noises, there were a lot of people, there was a beeping sound that was going on and like the nurses conversations ... that made it a little realistic." (P14)

> "You kind of feel the anxieties of everyone else when you're in the ER. I definitely felt that I was there." (P25)

> "Not super realistic, but I recognize there's limitations ... But I noticed that the doctors were wearing Crocs ... very accurate. So many of them wear Crocs. So I was like, ooh, immersion. That feels like a real experience." (P11)

Participants felt that they were physically present in the virtual emergency room and had the urge to be proactive in solving issues they witnessed. They were motivated to take another user's perspective, embodying the role in order to actively listen to what the virtual agents were saying. When a particular user group faced a problem, they wanted to stand up, interact, and assist others, showing prosocial behaviours, especially if they were taking the perspectives of the medical staff:

> "I just wanted to hear the conversations better. If I felt like the nurses were talking ... I switched to the front desk ... I was just trying to maximize the amount of information I can get." (P12)

> "I really wanted to jump out and say, oh, yeah, you could come to the desk here and just talk to me. Because I was embodying the person like the clerk at the desk." (P30)

> "I felt almost like I wanted to get up out of my seat and see if I could help ... I was worried that I should be able to interact with the people around me because it was something that I could realistically help somebody with." (P1)

The immersive environment helped participants feel that it illustrated a realistic scenario. Participants were reacting to their surroundings, engaged in the situation to the extent that it impacted their feelings and emotions, being stressed, overwhelmed, and feeling helpless. This motivated them to want to offer help; step in and take action to address user problems and frustrations as if they were in the virtual environment, treating virtual, animated agents as actual peers they can interact with.

5.4.2 Empathy Emerged as both Understanding and Feeling

Participants stated that they were mostly trying to understand the user's frustration, as their task is to be a researcher/designer hoping to identify the user's problem and needs to ideate a solution, indicating cognitive empathy. Through hearing virtual agents' dialogues, they wanted to understand their problems in an attempt to help them:

> "I just try to understand what they're saying, maybe to help them out a little ... in such a way that they're not worried anymore." (P12)

However, affective empathy was also fostered among participants, generating feelings of irritation and dissatisfaction with the virtual avatars. Interestingly, when participants did feel the user frustrations, they empathized more commonly with patients, even if they took the perspective of the medical staff, not the patient. Taking the perspective of the patient definitely influenced them to feel empathetic towards them, but participants taking the medical staff's perspective also felt patient frustrations. Participants found it easier to feel patient frustrations as many share the common experience of hospital visits as patients themselves:

> "I would say I feel more difficult frustration because I kind of like treat myself as one patient in the ER" (P23)

> "From medical staff it's more about understanding and on patient side you more empathize because in real life you also can be in that situation." (P22)

Understanding *and* feeling user frustration simultaneously was also common among the participants. Participants felt the user's frustrations by hearing and observing key pain points in a virtual environment while actively trying to understand the user's problem and provide a solution for them. Both affective and cognitive empathy were used within the process of facilitating a complete picture of the user story, as sympathy led to recognition of the problem:

> "I would say it's a bit of both. There were times where I understood, yes, this is a problem that they have. Like for instance, I believe at the beginning where the lady was complaining about why there's no way to know if there's even a cue, if she's even on a queue. I understood that ... you want to know where you are ... But then there were also times where I was frustrated because this even happened at the end when this guy was coughing out loud and this other patient walks in asking for help and nobody's coming to attend to the patient." (P6)

> "I sympathize with the patients and the staff, because in real life, this is what we're kind of going through right now in the medical field ... I also think objectively of. These are the concerns that we know that we have, what can we do do to improve the system so we can get better access time for the patients to be seen to be treated and do a high turnover rate with the patients, too, with newer incoming patients. So it's a little bit of both, honestly." (P7)

The empathy fostered through the VR experience shaped where participants directed help. Both affective empathy, feeling the user's frustration, often led participants to prioritize problems that will benefit that specific user directly and indirectly. For example, feeling patient frustration sometimes shifted participants' focus on wanting to take action for the medical staff's problems, as they believed that solving their problems would ultimately ease patients' experiences. However, understanding the context also contributed to participants helping a specific group of users, as they can see the interconnected relationship of how one group influence the quality of experience of the other group:

> "Patients obviously are coming in because they want to get out faster. And so it's the quality of experience that you give them. I think that is directly related to the staff ... I think if there was just more alignment between staff, then those situations could be resolved, and then that creates a more fluid experience in the emergency room." (P3)

> "The organization seems to be really poor. None of the staffs were organized and due to that, there were like a whole lot of patients being waiting in the emergency room, which also caused a really stressed culture around the whole place ... there were a lot of patients waiting in the emergency room ... and maybe due to that, it would have been better if they had more staff available." (P15)

5.4.3 Recognizing the User Groups of Perspective-Taking

With perspective-taking interaction in VR, either switching perspective, medical staff or patient, participants were able to embody and take the perspective of the user they are acting. This theme covers responses of how participants recognized that they were taking the perspective of a specific user group, or if they had at all.

The visual elements that show aspects of the specific user hinted participant the user group they were taking perspectives of, reminding them that they are embodying a particular user. Specifically, the participants who took the perspective of medical staff were sitting behind the reception desk, which made them feel like they were medical staff:

> "I did feel like I was a medical staff ... I was like sitting behind a desk, but I think kind of just like that placement made me feel like I was more a medical staff and because they would come and talk right beside me right beside the desk and like there were the machines up there. So it felt more like I was like a medical staff versus like as the patient." (P24)

Participants felt that they were aware of the user group they are taking the perspective of by seeing where they are located in the environment, the user group near them, and the user group they belong to. The virtual environment showed a clear distinction between the user groups by dedicating a separate section of the room, like a real emergency room. They were able to distinguish two different user groups and recognize how that impacts their understanding of where they are and who they are.

> "I feel like the proximity really helped because in like a real life scenario, there's a difference between being super close and super far and just acknowledging that ER staff are like the front desk workers ... separated from patients; they're not in that cohort. There's a difference between being in that group and observing that group." (P16)

Furthermore, participants felt that being closer to a particular user group allowed them to hear and understand better. They felt that all medical staff dialogue is on the medical staff side of the environment, and patient staff dialogue is all on the patient side of the environment. Thus, participants from the switching participant condition respond that they switched to understand and hear better.

> "I was just fully trying to listen in and get closer to their voices. And then switching into the staff to see if I could get a little bit closer or if I could see a little bit clearly more clearly." (P10)

In some cases, due to the role of UX researcher/designers that participants took for the tasks, sometimes participants still recognized as themselves as the respective roles, not the user group they were taking the perspective of:

> "There were times when I felt like I was a researcher, but there were also times when I felt like I was a staff. I will say most of the time I was feeling like a researcher because I wanted to step in and try and fix the problems." (P19)

5.4.4 Switching Perspective Interaction Technique Provides Unique Opportunities

Participants found Switching Perspective Interaction to be a powerful method to understand the holistic user story, widening their understanding, taking a look at both sides. They saw switching perspectives as an interaction technique to see a bigger picture, a holistic understanding of the entire emergency scenario, as they now can see the same scenario from different points of view. Participants think that this would widen their understanding of users as they are in multiple different people's shoes, influencing their design decisions to work on a solution that satisfies both user groups, or working on the environmental changes that will impact both:

> "I could see the big picture. It's like I see a problem in one person's point of view and I see a problem in a second person's. I can think of a solution that makes both of them happier." (P26)

> "Because if I'm sitting there from the perspective of the medical staff, I might. If I was a different person, I might not be thinking of things from the patient's

> perspective, and I might be trying to solve the problem for the medical staff. So allowing me to switch, then that's kind of forcing me to think about it from somebody else's perspective." (P17)

Participants also think that switching perspectives can balance out the empathy level for the frustration of the two user groups, having a uniform understanding that values both groups equally:

> "I think one of the biggest benefits is that you have a much more equal weighing or emotional weighing of the patient's problems versus the staff's problems. Because you feel more of it when you're able to switch, you feel more of an obligation to to listen to both sides." (P30)

A unique use case for switching perspective was that you can escape the context you are in. Unlike switching perspective to move closer to the virtual avatars to hear their conversation and see the situation better, some participants noted that they used switching perspective to move away from the situation as they felt uncomfortable, and did not want to be frustrated:

> "So switching perspective would help if you're trying to escape a frustrating or a frustrating scenario or a scenario where there's a lot of pressure on you." (P19)

Lastly, participants mentioned the optimal use cases of switching perspectives within the process of UX design and research, not limited to the empathizing process. They do believe that this interaction can be a tool to empathize with users in the empathizing stage of the design thinking process, helping them to think deeper and find the underlying issue that could be solving a specific or holistic problem. The interaction technique can be used in the earlier stages of the design process to brainstorm ideas, empathize, and ideate:

> "This is very interesting and I really liked actually [that] you came up with this idea. So I think one of the applications definitely gonna be for empathizing and defining the problem." (P18)

> "I think it could even come up in the brainstorming or even identifying the problem. Because maybe this problem that I think is the hospital's problem. For example, if I were the patient, and I [would] think everything has to do

> with the hospital staff [but] even just switching perspectives and becoming the hospital staff, I can understand. Maybe it isn't the hospital staff that's the problem ... It's not just inefficiency. It's actually on, an organizational level. I see an issue here." (P26)

In addition to being used at specific stages of design thinking, participants also mentioned that it could be a good communication tool throughout the design and research projects to inform the stakeholders of the problem space and frustration, making sure people are on the same page but also deepening their understanding of why this problem is important to solve. As switching perspectives in VR translates frustrated emotions, elevating the importance of the problem space:

> "I think it's also going to be a good handy tool to just communicate your thoughts with stakeholders, people who want to invest in such applications or systems. We say that this is a problem, but they don't get it. So this might help to provide a shared understanding about the situation and the problem and make it more tangible for the people who have money and want to invest in such applications or platforms." (P18)

5.4.5 Switching Perspectives Hinder In-Depth Understanding

Participants reported some drawbacks of the switching perspectives interaction, and think that switching perspectives is not optimal in cases such as needing to understand one user group in-depth fully. One may miss the information and context if they are constantly switching back and forth, disrupting their focus, losing track of which perspective I was taking of:

> "I do think the drawback would be that you can like get the situation confused and correlate things that aren't necessarily correlated and kind of." (P3)

> "The drawbacks, I think, is that it kind of takes you out of this scenario a bit more by having like somewhat unrealistic switch between where you fade in, fade out." (P8)

> "You could miss on those things which the patients are going through for example, if I'm observing the medical staff, there could be something happening all around with the patient side and I would miss that." (P22)

In contrast to the switching perspective, participants found that seeing only from one perspective helps them understand that perspective in depth, as they will prioritize the group that they see. Taking a medical staff or patient perspective allows them to focus and grasp a better understanding of what the user group wants and needs.

> "But if I just focused on one perspective, it will show more details or deeper thinking about the users. Like the specific user group." (P27)

> "If I go to a single perspective, the thing is I would be totally observing the patient's view. I would be feeling in that sense that I'm a patient now ... From that perspective, I just think that I would get more depth of a knowledge. And also clearly understanding what the user actually needs or feels apart from that." (P22)

This shows that participants saw the limitation of switching interaction tools compared to single-perspective interaction in facilitating deeper empathy and understanding of users.

5.5 Summary

The quantitative data and qualitative data from the user study comparing the switching perspectives interaction method to two single-perspective interaction methods were analyzed and reported in this chapter. I conducted a statistical analysis revealing significant findings from the Avatar Embodiment Questionnaire and the IRI Questionnaire. Using Content Analysis and Reflexive Thematic Analysis, qualitative data were analyzed. The Content Analysis revealed the types of user problems, user needs, core problem areas and the design solution that participants ideate, reporting the average number or counts of the iterated codes. I present five themes developed through Reflexive Thematic Analysis, which provide stories and phenomena regarding participants' experiences in the study.

Chapter 6

Discussion

In this chapter, I discuss visual cues of user roles that increase embodiment, the changes in empathy, the idea of location within the perspective-taking, and designing for the end group. I conclude this section with suggestions on how different perspective-taking methods could be utilized to understand users through VR for UX research and design.

6.1 Visual Cues of User Roles Increase Embodiment

The avatar embodiment questionnaire indicated that participants in the medical staff condition reported a greater sense of ownership of the body compared to those in the patient condition, not supporting H1. A sense of ownership is one of the key components in embodiment, creating empathy and knowledge to understand people [7]. The interviews further revealed that participants felt they were more aware that they were the medical staff when embodying that role's avatar, due to visual elements that the participant sees. As mentioned in Chapter 5, participants saw the avatar that they embody is behind the desk, wearing medical staff's clothes:

> "I got pretty much amazed by the fact that once I looked down, I could see my hands, I could see my shoulders and I'm wearing the uniform, my desk and all, which was like my legs and all, which was like very cool that I can also see myself." (P5)

This gave a sense of owning a specific body that has a defined role – medical staff. By seeing the visuals that hint at the avatar that participants are taking the perspective of and embodying, participants were mindful of the roles of the avatar.

Unlike the medical staff perspectives, the patients had fewer visual elements that strongly communicated their role to the participants. When building the VR environment, I made a deliberate design decision to use avatars that represent each user group with visual elements such as clothing. As mentioned in subsection 3.2.1, I selected an avatar that wears medical scrubs as a medical staff avatar, where participants can embody and take the perspective of in switching perspectives or medical staff conditions. However, as patients could be anyone without a specific set of archetypal clothing, an avatar with no specific job uniform was selected to ensure that participants do not think they are embodying a character with a certain role who is also a patient, adding another complexity. The patient avatar was seated in the open area of the waiting room with other patients. Although this reflects the ecological validity of where the participants would be located and what they would most likely be wearing, it is not a strong enough illustration compared to the medical staff. Thus, lack of specific visual cues about the avatar possibly contributes to less ownership and other subscales, such as appearance, response, and multi-sensory, contributing to the lowest embodiment score out of all the conditions.

The lack of visual cues can also explain why the avatar embodiment questionnaire scores for switching perspectives conditions always lie between medical staff and patients. Although it is not statistically significant, the switching perspective condition scored in the middle range of the medical and patient conditions, as shown in Figure 5.1. This might suggest that as participants were switching back and forth from one perspective to another, they experienced embodying both avatars; a clear role through a clear visual, and a less-defined role through a less-effective visual. Further study is needed to clarify, but this might support why the embodiment level the participants experienced was placed between the medical staff and the patient.

I previously hypothesized that switching perspective would have the lowest embodiment level, as participants would feel the sensation of losing control of their body, no longer occupying and owning the avatar. However, the findings suggest that visual elements that shape the experience may be more valuable in embodiment. The visual cues may have played a role in constructing the mental model of taking a specific person, a user's perspective, for participants. The surrounding virtual environment and the avatar's physical appearance may be important for effective embodiment.

This embodiment, influenced by the visual cue, may seem to contribute to role-playing rather than perspective-taking, as it allows researchers and designers to take the role of a specific user in the problem area. However, role-playing is where one acts and plays to be that role, with freedom in interpreting the role and selecting how to respond [73], meaning that it is not a method to develop understanding of the role precisely like UX research. UX practitioners who would use VR to empathize with and understand users

would use the technology with full awareness and a concrete goal: to research the person they are taking the perspective of, not merely acting like one. Although the visual cues may create assumptions about the users before immersing into their experience, UX researchers and designers should already know that good design thinking skills include not relying on assumptions; they should always be challenged for successful design thinking, resulting in better ideation of creative solutions [52]. As the users of the VR perspective-taking methods studied in this thesis would be UX practitioners who are fully aware of their role, tasks, and goals, the visual cues should not hinder their motivation to research the users and shift their focus to enjoying the role-playing simulation.

6.2 Changes in Empathy

Findings from the IRI questionnaire indicate that different types of empathy are fostered after seeing the VR scenario, which partially supports H2. *Empathic concern* and *personal distress* measures affective empathy, the emotional responses, while *perspective taking* and *fantasy* measures cognitive empathy, how one understands and thinks about others in relation to oneself [30]. The statistical test shows that there is a significant change in all IRI subscales between switching perspectives and patient perspective conditions, showing changes in affective and cognitive empathy. Although other comparisons do not show statistical significance, Figure 5.2 shows the overall trend of change in IRI empathy scores. In this section, I will be discussing the changes in cognitive and affective empathy, providing insight on the underlying reasons why these occurred.

6.2.1 Cognitive Empathy

For cognitive empathy, there is an increase in the *fantasy* IRI subscale for all conditions. *Perspective taking* increased within medical staff and patient conditions, while switching between perspective conditions decreased.

The interview data support this trend and provide an explanation for why this may have occurred. Participants mentioned that switching interaction takes them 'out' of the experience, feeling detached from the perspective they are seeing. This unusual sensation of being able to switch to different bodies expanded their imagination, positively impacting their *fantasy* level, but disrupted their *perspective-taking* and inhibited participants from paying close attention to a single perspective:

> "I feel like it would take me out of the immersion ... because you can't really switch bodies in real life." (P11)
>
> "Switching and changing the perspective [changes] angle of looking at things ... I think it kind of tricks the mind so you think, I'm now imagining that I'm changing, switching my body. When that switch happens, your brain also thinks differently." (P18)
>
> "Like a fantasy in a sense, because you would wake up to be another person. Suddenly, you're just changing your seat to be someone else at the table. It's kind of like those movies when you just wake up and you become another person." (P2)

Switching perspectives may hinder concentration on a specific user group, as it exposes multiple viewpoints of the users within the problem space to participants. However, interview data shows that being able to see multiple perspectives widens participants' understanding of the problems, hearing both user groups, and identifying the bigger problem. Table 5.11 shows the counts of the core problem the participants wished to work on as UX researchers/designers from the questionnaire. Participants from the switching perspectives condition focused more on the environmental problems compared to other conditions, defining that the core problem is the emergency room setup that impacts both user groups. This reveals that switching perspectives influenced them to prioritize the bigger picture problems. In terms of cognitive empathy, switching perspectives might have limited participants' thinking to create an in-depth understanding of a specific user problem compared to the patient or medical staff perspective, but it broadens the scope of the user problems they understand.

Additionally, participants from the switching perspective condition showed more prosocial behaviours. As shown in Table 5.12, the switching perspective condition had a higher average of ideated solutions, utilizing participants' imagination in designing different solutions to the user problems. Prosocial behaviours indicate *imagine-others* [36], a type of perspective-taking method that is closely connected to cognitive empathy. The increase in the *fantasy* subscale and the generation of more ideas suggest that switching perspective interaction methods contribute to fostering cognitive empathy.

6.2.2 Affective Empathy

Unlike other conditions, the medical staff's perspective shows the opposite trend in the change of subscale scores regarding affective empathy compared to other conditions. *Em-*

pathic concern decreased in the medical staff condition, while it increased in the switching perspective and patient conditions. For *personal distress*, the medical staff condition increased, but the switching perspective and patient conditions all showed a decrease in scores.

The findings from the interview complement this as participants had more empathic frustrations towards patients more due to their personal experiences. Taking a perspective of the patient prompted participants to recall past experiences in similar environments such as hospitals, emergency rooms, and clinics, fostering emotional connection:

> "I just had a surgery like two months ago ... but I did have to return to the hospital ... so I did spend a little bit of time in the ER then ... So, there was some experience of [that] reminded me a bit of that ... It reminded me the most of the feeling that I got. It just reminded me of the recent experience that I had." (P21)

Unlike other conditions, the medical staff perspective-taking condition was the only condition where participants were not able to embody and take the perspective of the patients. This suggests that when participants take on a perspective aligned with their prior experiences, it positively influences their affective empathy towards that user group. Therefore, the empathic concerns for the patient group increased after using VR as a perspective-taking tool, revealing potential in facilitating affective empathy.

The increase in *personal distress* within the medical staff condition but the decrease in all other conditions may be explained by the lack of personal connection. Most participants claimed to have experience as patients visiting hospitals, but only some had a connection to medical staff as their close family members work in that profession. Due to the uncomfortable position and unusual perspective, participants felt unease and distress in hearing medical staff's conversations because they were worried that the failures within the medical staff would impact the patients. P19 even mentioned that "For the staff, I was feeling I was mad." As participants in the medical staff condition were only taking the perspective of the medical staff, they felt the most discomfort and distress due to the helplessness they felt. This shows that feeling personal distress can be influenced by the relationship between the person using the VR and the role that they are taking. If they do not have prior experience with the role they are taking, they have less knowledge while feeling uneasiness, negatively affecting their emotions and increasing personal distress.

An additional explanation for the increase in *personal distress* is that participants in medical staff conditions may have felt frustrations that they acknowledge as manageable

and solvable. Participants mentioned that for patients, they were mostly frustrated with waiting and not getting help, which is something uncontrollable on the patient's end during emergency room visits. Contrary to this, participants mentioned that medical staff are distressed due to their inability to help participants while they are in a position where they could:

> "I feel like [medical staff] were also really frustrated and they were not like getting their job done." (P15)

The type of stress that medical staff face is different from that of the patients. Patients are frustrated about themselves not meeting their needs, but medical staff are frustrated about themselves not meeting others' needs. This difference in distress may be another reason why personal distress increased for medical staff condition.

6.3 Is it the Location or the Perspectives?

As participants were taking perspectives of two different users, the patient and the medical staff, they often mentioned the location of the different avatars and how it influenced their understanding and experience. During the interview session, participants reported feeling closer to the group their avatar belonged to when they took its perspective. For example, they were able to hear patient problems better because their patient avatar is located in the waiting room, closer to all the conversations about the patient problems. Participants even felt that they would miss the conversations of the other user group if they were observing from another user's perspective. Being fixated on one perspective means being restricted to one location, and participants believed that they would miss it as they are further away, not being able to see or hear things.

I designed the virtual environment to depict a compelling emergency room, so having a patient avatar in the waiting room and having a medical staff avatar at the reception desk made logical sense. However, I designed the virtual avatar's movement and scenario so that not all frustration dialogues happen in their respective sections. The medical staff's conversation about the bottleneck issue happened in front of the patient avatar, and the virtual patient expressed frustration about filling out medical forms, which was closer to the medical staff avatar. Having only one problem in the opposite location may have influenced participants to think *most* problems occur in the location, but it is interesting that participants thought that they were *always* physically closer, location-wise, to problems, although that was not the case.

Based on their interviews, not being able to switch perspectives would have influenced participants to understand the other user group problems negatively. If location limited participants' understanding as they claim, the switching perspective condition should report more problems and needs for both user groups. Table 5.10 shows that participants in the switching perspective identified more user needs compared to the two other conditions, but Table 5.9 does not show that switching perspectives identified more user problems.

Table 5.9 and Table 5.10 show that participants in the medical staff condition identified more medical staff-related problems and needs compared to patient-related problems and needs, showing how they identified their own group's elements more. However, patient condition also found medical staff-related problems and needs slightly more, with a minimal difference in the average number of items identified, only partially supporting H3. Thus, we cannot simply assume that location was the most important factor that impacted their understanding of in-group and out-group situations.

One notable finding is that participants in both single-perspective conditions found more interrelated problems compared to switching perspectives, identifying 2.1 problems on average per participant. This indicates that participants in the single perspective conditions were able to see the connection between the groups better. In the interview, participants mentioned that looking through one perspective allows for an in-depth understanding:

> "If you want to actually go in-depth of what the user feels, [then] you require individual perspectives." (P22)

The in-depth understanding that participants refer to may mean contextual understanding of how the different problems and frustrations relate to one another. Taking the perspective of a single role makes participants recognize the role of their avatars more clearly, without any disruption from switching the roles back and forth. Seeing the entire user story through one perspective might have provided participants with an uninterrupted experience from switching perspectives, allowing them to create an in-depth understanding, connecting the dots and interpreting how the other user group's problem influences their own user group. Here, we can deduce that taking the perspective of the specific role assisted in knowledge creation to understand users.

6.4 Designing for *a* User or Designing for *the* User

The findings from the content analysis show that participants in the medical staff condition ideated slightly more medical staff-related solutions while patient condition ideated more

patient-related solutions, as shown through Table 5.12, supporting H4. However, when participants were asked to select one core problem area they wished to work on, many selected the opposite group's problem instead of the group of whom they took the perspective. Table 5.11 shows that 5 out of 10 participants from the medical staff condition selected more patient problems to focus on, and participants from the patient condition selected more patient problems to solve. Although the number of ideated solutions differ by one, it contradicts the results from Table 5.12.

The interview data provides some explanation for this phenomenon. Participants described that working on the opposite user group's problem will ultimately benefit their own user group in the end. They recognized that the problems were interrelated, and solving other groups' problems would resolve the frustration their user group faces. Thus, this may suggest that the prosocial behaviours of helping a specific group and providing a solution may not be targeting *that* user. From this, we can infer that participants' true intention was to address problems within their own group. A user that they are designing and solving for may not be *the* user they are focusing on.

6.5 Suggestions for Using Switching Perspectives and Single-User Perspective Interaction

Based on the findings from the study, I present the following suggestions on how and when to utilize the switching perspective and single-user perspective interaction, and also some general suggestions on how to use VR as a perspective-taking tool for UX research and design.

Clearly show the target user's role through visual cues to increase embodiment

Through my study, I found that visual elements, such as how believable the environment and the avatars are in the virtual environment, play a key role in facilitating empathy and embodiment, ultimately impacting one's understanding of the user group. A study by Waltemate et al. show that personalization of a virtual avatar to resemble the user's appearance in the real world increases body ownership, presence and emotional responses [68]. This result is quite similar to my study findings; a closer depiction of yourself/user group increases ownership of the avatar depicting yourself/user group. I recognize the current limitations of the VR development software, such as Unity, and that we cannot bring hyper-realistic visuals to VR. However, visual cues do not have to be detailed or

realistic. If it serves the purpose of defining the avatar's role clearly, it is still effective in establishing a definite role for the avatar that researchers are taking a perspective of, which is important for fostering empathy and understanding.

Use switching perspectives interaction for holistic, environment understanding

When researchers and designers want to develop a holistic understanding of the problem space that includes multiple user groups and stakeholders, switching perspectives in VR interaction would be ideal. Through my study, this interaction shows the ability to foster both affective and cognitive empathy, but may not be well-suited to facilitate deep knowledge of a specific group. However, it can increase the spatial awareness of the environment that needs a solution, providing opportunities for a third problem that is not directly related to only one user group in the space. It can be used to find a bigger-picture on the user problem space. Switching Perspectives Interaction could allow researchers and designers to go outside of the box, not relying only on what the user group says but observing what the users do and the related settings – a key to UX research and design.

Use single-user perspective interaction for in-depth understanding

When researchers and designers want to understand in-depth knowledge of a particular user group, single-user perspective interaction would be ideal to use. Observing the VR scenario from one perspective, from start to end, can create an in-depth understanding of the user group from whose perspective we take, as well as the relationship with other user groups. It facilitates both affective and cognitive empathy, resulting in prosocial behaviours that prioritize the single user group. However, researchers and designers should be careful when selecting the user group to take the perspective of. If they have no prior knowledge of the user group from a specific profession, it may be hard to feel connected, causing unnecessary personal distress and hindering cognitive understanding. Thinking about the relationship to other user groups in the virtual environment is important. Depending on the user groups, some perspectives may be more prone to feeling distress as researchers and designers may feel distress of other groups that is connected to their own group.

Chapter 7

Limitations and Future Works

One limitation of this research is that the VR scenario and interaction technique limiting participant movement may diminish some sense of embodiment and perspective-taking. To control any unknown variables and ensure that all participants have a similar VR experience, I made a design decision that participants will be seated stationary, mostly observing the user stories and the virtual environment. While this design controlled the participant experience, the lack of interaction with other virtual avatars and the inability to move around may have resulted in a lower embodiment score throughout the conditions.

I used a Meta Quest 2, which was not the newest VR device at the time the study was conducted. Compared to the newest model, such as the Meta Quest 3, it has a lower resolution, which may have negatively influenced participants' experience when watching the VR scenario through the headsets. Additionally, there were some technical limitations in simulating avatar movement that may not seem very realistic, which participants also noticed. Refining the avatar's action and overall quality of the virtual environment to be more hyper-realistic would be an aspect to improve, to gather data that has not been impacted negatively due to technological limitations.

Another limitation is that the task to identify problems and needs may have been correlated with memory recall instead of cognitively understanding the problem. Although participants were not asked to remember the VR scenario, their task was to act as a UX researcher/designer and identify user problems and needs. After the task, they were asked to fill out questionnaires, including questions asking them to write down all the problems. Due to the positioning effect in memory recall, where people are more likely to recall the first and last items [51], participants may have recalled the first and last problems that were shown in the VR environment, which were long wait times and a deteriorating patient

with no immediate support. Without this limitation, ideally, participants would be able to identify and select problems and needs that were most important in their understanding.

Although I intended to recruit participants who are 18-64 years old, the participants' ages ranged from 19 to 33, skewed towards a younger population. This excluded insights from the older population in data collection, resulting in collecting data from participants who are more familiar with new technology, such as VR. In an ideal setup, I would recruit participants who are older than 33, collecting data from a more diverse sample for analysis.

For future work, adding controlled interaction to each perspective would explore the full potential of VR as an interactive, perspective-taking tool. In addition, conducting a usability or exploratory study focusing on only the switching perspective would reveal insights, providing opportunities to improve the functionality and design. It would be beneficial to recruit professional UX researchers and designers for this study, as they can bring more insights on improving the switching perspectives interaction method based on their lived experiences.

Additionally, future works can examine other types of users to switch perspectives. This research focused on the different user roles within the problem area, but I am curious if switching perspectives between different age groups (children, adults, elderly) or the height of the user group influences their understanding of empathy in the same way as the user case illustrated in this thesis.

Chapter 8

Conclusion

In this thesis, I propose the switching perspective interaction method created through Unity that allows participants to switch perspectives from one user to another, whenever they wish, by pressing a button on the handheld controllers that also depict their hands in the virtual environment. Through a mixed-methods, between-participant study, I compared the switching perspective interaction to two single-perspective interactions, with the two user avatars being a medical staff member and a patient. Participants observed the VR scenario that depicts an emergency room with two user groups, medical staff and patients, with the task of understanding user problems and needs. The purpose of this thesis is to reveal how different perspectives influence researchers' and designers' understanding and empathy for user problems in virtual environments, and also how switching perspectives influences their understanding of user problems and ideation of user solutions.

Our results show that both affective and cognitive empathy are facilitated across the different perspectives, with some differences in where this empathy and understanding are directed, and in their level of depth. While single perspectives show strength in understanding the respective user group in-depth, connecting the stories and gathering detailed insights, switching perspectives is beneficial to widen their understanding, encompassing both users and identifying the bigger picture problems. The findings reveal the importance of visuals and roles in using VR as a perspective-taking tool effectively in UX research, as they impact researchers' and designers' empathy facilitation. To conclude, I provide suggestions on how switching perspective interaction and single-perspective interaction should be used to understand and empathize with users, with recommendations on how to use VR as a perspective-taking tool generally in UX research and design.

References

[1] Maryam Abhari, Kaveh Abhari, Madison Drinkwine, and Jordan Sloan. 2021. Extended Reality (XR) Applications in Architectural Practice: Towards a Development Framework. In *HCI International 2021 - Late Breaking Papers: Multimodality, eXtended Reality, and Artificial Intelligence*. Vol. 13095. Springer International Publishing, Cham, 185–196. https://doi.org/10.1007/978-3-030-90963-5_15 Series Title: Lecture Notes in Computer Science.

[2] Adobe. 2025. Mixamo. https://www.mixamo.com/. Accessed: 2025-05-12.

[3] Sun Joo (Grace) Ahn, Amanda Minh Tran Le, and Jeremy Bailenson. 2013. The Effect of Embodied Experiences on Self-Other Merging, Attitude, and Helping Behavior. *Media Psychology* 16, 1 (Jan. 2013), 7–38. https://doi.org/10.1080/15213269.2012.755877

[4] Sojung Bahng, Ryan M. Kelly, and Jon McCormack. 2020. Reflexive VR Storytelling Design Beyond Immersion: Facilitating Self-Reflection on Death and Loneliness. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20)*. Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3313831.3376582

[5] C. Daniel Batson, Shannon Early, and Giovanni Salvarani. 1997. Perspective Taking: Imagining How Another Feels Versus Imaging How You Would Feel. *Personality and Social Psychology Bulletin* 23, 7 (July 1997), 751–758. https://doi.org/10.1177/0146167297237008

[6] Mariette Bengtsson. 2016. How to plan and perform a qualitative study using content analysis. *NursingPlus Open* 2 (Jan. 2016), 8–14. https://doi.org/10.1016/j.npls.2016.01.001

[7] Niclas Braun, Stefan Debener, Nadine Spychala, Edith Bongartz, Peter Sörös, Helge H. O. Müller, and Alexandra Philipsen. 2018. The Senses of Agency and Ownership: A Review. *Frontiers in Psychology* 9 (April 2018). https://doi.org/10.3389/fpsyg.2018.00535 Publisher: Frontiers.

[8] Virginia Braun and Victoria Clarke. 2019. Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health* 11, 4 (Aug. 2019), 589–597. https://doi.org/10.1080/2159676X.2019.1628806 Publisher: Routledge _eprint: https://doi.org/10.1080/2159676X.2019.1628806.

[9] Anna Rose Lucy Carter, Miriam Sturdee, Alan Dix, Dani Kalarikalayil Raju, Martha Aldridge, Eunice Sari, Wendy Mackay, and Elizabeth Churchill. 2022. InContext: Futuring User-Experience Design Tools. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts*. ACM, New Orleans LA USA, 1–6. https://doi.org/10.1145/3491101.3503739

[10] Yu-Shan Chang, Chia-Hui Chou, Meng-Jung Chuang, Wen-Hung Li, and I.-Fan Tsai. 2023. Effects of virtual reality on creative design performance and creative experiential learning. *Interactive Learning Environments* 31, 2 (Feb. 2023), 1142–1157. https://doi.org/10.1080/10494820.2020.1821717 Publisher: Routledge _eprint: https://doi.org/10.1080/10494820.2020.1821717.

[11] Gopal Singh Charan, Raman Kalia, Sunil Kumar Dular, Rajesh Kumar, and Kiranpreet Kaur. 2025. Challenges faced by doctors and nurses in the emergency department: An integrated review. *Journal of Education and Health Promotion* 14 (Jan. 2025), 2. https://doi.org/10.4103/jehp.jehp_462_24

[12] Dimitra Chasanidou, Andrea Alessandro Gasparini, and Eunji Lee. 2015. Design Thinking Methods and Tools for Innovation. In *Design, User Experience, and Usability: Design Discourse*, Aaron Marcus (Ed.). Springer International Publishing, Cham, 12–23. https://doi.org/10.1007/978-3-319-20886-2_2

[13] Alex Close, Stephen Field, and Robert Teather. 2024. Visual thinking in virtual environments: evaluating multidisciplinary interaction through drawing ideation in real-time remote co-design. *Frontiers in Virtual Reality* 4 (Jan. 2024). https://doi.org/10.3389/frvir.2023.1304795 Publisher: Frontiers.

[14] Freesound Community. 2022. kwun tong hospital ambience9.wav. https://pixabay.com/sound-effects/012174-kwun-tong-hospital-ambience9wav-58596/

[15] Mark H. Davis. 1983. Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology* 44, 1 (Jan. 1983), 113–126. https://doi.org/10.1037/0022-3514.44.1.113

[16] Anthony Elliott, Brian Peiris, and Chris Parnin. 2015. Virtual Reality in Software Engineering: Affordances, Applications, and Challenges. In *2015 IEEE/ACM 37th IEEE International Conference on Software Engineering*, Vol. 2. 547–550. https://doi.org/10.1109/ICSE.2015.191 ISSN: 1558-1225.

[17] Fabrizio84. 2022. Cough. https://pixabay.com/sound-effects/cough-46034/

[18] Fabrizio84. 2022. Cough. https://pixabay.com/sound-effects/cough-82181/

[19] Jodi Forlizzi and Katja Battarbee. 2004. Understanding experience in interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*. ACM, Cambridge MA USA, 261–268. https://doi.org/10.1145/1013115.1013152

[20] Alan D. Fraser, Isabella Branson, Ross C. Hollett, Craig P. Speelman, and Shane L. Rogers. 2024. Do realistic avatars make virtual reality better? Examining human-like avatars for VR social interactions. *Computers in Human Behavior: Artificial Humans* 2, 2 (Aug. 2024), 100082. https://doi.org/10.1016/j.chbah.2024.100082

[21] Jennifer Fromm, Jaziar Radianti, Charlotte Wehking, Stefan Stieglitz, Tim A. Majchrzak, and Jan vom Brocke. 2021. More than experience? - On the unique opportunities of virtual reality to afford a holistic experiential learning cycle. *The Internet and Higher Education* 50 (June 2021), 100804. https://doi.org/10.1016/j.iheduc.2021.100804

[22] Courtney Lynn Gallagher. 2017. Sketching for Ideation: A Structured Approach for Increasing Divergent Thinking. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, Denver Colorado USA, 106–111. https://doi.org/10.1145/3027063.3048424

[23] Shaun Gallagher. 2000. Philosophical conceptions of the self: implications for cognitive science. *Trends in Cognitive Sciences* 4, 1 (Jan. 2000), 14–21. https://doi.org/10.1016/S1364-6613(99)01417-5

[24] Bright Vision Game. 2022. Hospital Corridor. https://assetstore.unity.com/packages/3d/environments/hospital-corridor-231428

[25] Bright Vision Game. 2023. Hospital Wardroom. https://assetstore.unity.com/packages/3d/environments/hospital-wardroom-253867

[26] Andrea Alessandro Gasparini. 2015. Perspective and Use of Empathy in Design Thinking. (2015).

[27] Ashlinder Gill, Kerry Kuluski, Liisa Jaakkimainen, Gayathri Naganathan, Ross Upshur, and Walter P. Wodchis. 2014. "Where Do We Go from Here?" Health System Frustrations Expressed by Patients with Multimorbidity, Their Caregivers and Family Physicians. *Healthcare Policy* 9, 4 (April 2014), 73–89. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4749886/

[28] Omri Gillath, McCall , Cade, Shaver , Phillip R., , and Jim Blascovich. 2008. What Can Virtual Reality Teach Us About Prosocial Tendencies in Real and Virtual Environments? *Media Psychology* 11, 2 (June 2008), 259–282. https://doi.org/10.1080/15213260801906489 Publisher: Routledge _eprint: https://doi.org/10.1080/15213260801906489.

[29] Amy Grech, Andrew Wodehouse, and Ross Brisco. 2023. Designer Empathy in Virtual Reality: transforming the Designer Experience closer to the User. In *IASDR 2023: Life-Changing Design*. Design Research Society. https://doi.org/10.21606/iasdr.2023.380

[30] Teresa Guilera, Iolanda Batalla, Carles Forné, and Jorge Soler-González. 2019. Empathy and big five personality model in medical students and its relationship to gender and specialty preference: a cross-sectional study. *BMC Medical Education* 19 (Feb. 2019), 57. https://doi.org/10.1186/s12909-019-1485-2

[31] Martin Guy, Jean-Marie Normand, Camille Jeunet-Kelway, and Guillaume Moreau. 2023. The sense of embodiment in Virtual Reality and its assessment methods. *Frontiers in Virtual Reality* 4 (Dec. 2023), 1141683. https://doi.org/10.3389/frvir.2023.1141683

[32] Béatrice S. Hasler, Daniel H. Landau, Yossi Hasson, Noa Schori-Eyal, Jonathan Giron, Jonathan Levy, Eran Halperin, and Doron Friedman. 2021. Virtual reality-based conflict resolution: The impact of immersive 360° video on changing view points and moral judgment in the context of violent intergroup conflict. *New Media & Society* 23, 8 (Aug. 2021), 2255–2278. https://doi.org/10.1177/1461444821993133

[33] Fernanda Herrera, Jeremy Bailenson, Erika Weisz, Elise Ogle, and Jamil Zaki. 2018. Building long-term empathy: A large-scale comparison of traditional and virtual

reality perspective-taking. *PLOS ONE* 13, 10 (Oct. 2018), e0204494. https://doi.org/10.1371/journal.pone.0204494 Publisher: Public Library of Science.

[34] Darragh Higgins, Yilin Zhan, Benjamin R. Cowan, and Rachel McDonnell. 2023. Investigating the effect of visual realism on empathic responses to emotionally expressive virtual humans. In *ACM Symposium on Applied Perception 2023*. ACM, Los Angeles CA USA, 1–7. https://doi.org/10.1145/3605495.3605799

[35] Samory Houzangbe, Dimitri Masson, Sylvain Fleury, David Antonio Gómez Jáuregui, Jeremy Legardeur, Simon Richir, and Nadine Couture. 2022. Is virtual reality the solution? A comparison between 3D and 2D creative sketching tools in the early design process. *Frontiers in Virtual Reality* 3 (Oct. 2022), 958223. https://doi.org/10.3389/frvir.2022.958223

[36] Xinhui Hu and Georgi. V. Georgiev. 2020. OPPORTUNITIES WITH UNCERTAINTIES: THE OUTLOOK OF VIRTUAL REALITY IN THE EARLY STAGES OF DESIGN. In *Proceedings of the Sixth International Conference on Design Creativity (ICDC 2020)*. The Design Society, 215–222. https://doi.org/10.35199/ICDC.2020.27

[37] X. Hu, V. Nanjappan, and G.V. Georgiev. 2021. Seeing from the users' eyes: An outlook to virtual-reality based empathic design research, Vol. 1. 2601–2610. https://doi.org/10.1017/pds.2021.521

[38] Unity Technologies Japan. 2024. UnityJapanOffice. https://assetstore.unity.com/packages/3d/environments/unityjapanoffice-152800

[39] Hans-Christian Jetter, Roman Rädle, Tiare Feuchtner, Christoph Anthes, Judith Friedl, and Clemens Nylandsted Klokmose. 2020. "In VR, everything is possible!": Sketching and Simulating Spatially-Aware Interactive Spaces in Virtual Reality. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM, Honolulu HI USA, 1–16. https://doi.org/10.1145/3313831.3376652

[40] Jamil Joundi, Yannick Christiaens, Jelle Saldien, Peter Conradie, and Lieven Marez. 2020. AN EXPLORATIVE STUDY TOWARDS USING VR SKETCHING AS A TOOL FOR IDEATION AND PROTOTYPING IN PRODUCT DESIGN. *Proceedings of the Design Society: DESIGN Conference* 1 (May 2020), 225–234. https://doi.org/10.1017/dsd.2020.61

[41] Sebastian Jäger, Arndt Allhorn, and Felix Bießmann. 2021. A Benchmark for Data Imputation Methods. *Frontiers in Big Data* 4 (July 2021). https://doi.org/10.3389/fdata.2021.693674 Publisher: Frontiers.

[42] Konstantina Kilteni, Raphaela Groten, and Mel Slater. 2012. The Sense of Embodiment in Virtual Reality. *Presence: Teleoperators and Virtual Environments* 21, 4 (Nov. 2012), 373–387. https://doi.org/10.1162/PRES_a_00124

[43] Jaana-Maija Koivisto, Sanna Kämäräinen, Katri Mattsson, Satu Jumisko-Pyykkö, Riikka Ikonen, and Elina Haavisto. 2025. Exploring Nursing Students' Experiences of Empathy and User Experiences in an Immersive Virtual Reality Simulation Game: Cross-Sectional Study. *JMIR Serious Games* 13 (Feb. 2025), e62688. https://doi.org/10.2196/62688

[44] Merlijn Kouprie and Froukje Sleeswijk Visser. 2009. A framework for empathy in design: stepping into and out of the user's life. *Journal of Engineering Design* 20, 5 (Oct. 2009), 437–448. https://doi.org/10.1080/09544820902875033 Publisher: Taylor & Francis _eprint: https://doi.org/10.1080/09544820902875033.

[45] Klaus Krippendorff. 2019. *Content Analysis: An Introduction to Its Methodology*. SAGE Publications, Inc. https://doi.org/10.4135/9781071878781

[46] Eva Köppen and Christoph Meinel. 2015. Empathy via Design Thinking: Creation of Sense and Knowledge. In *Design Thinking Research: Building Innovators*, Hasso Plattner, Christoph Meinel, and Larry Leifer (Eds.). Springer International Publishing, Cham, 15–28. https://doi.org/10.1007/978-3-319-06823-7_2

[47] Jérémy Lacoche, Eric Villain, and Anthony Foulonneau. 2022. Evaluating Usability and User Experience of AR Applications in VR Simulation. *Frontiers in Virtual Reality* 3 (July 2022). https://doi.org/10.3389/frvir.2022.881318 Publisher: Frontiers.

[48] Austin van Loon, Jeremy Bailenson, Jamil Zaki, Joshua Bostick, and Robb Willer. 2018. Virtual reality perspective-taking increases cognitive empathy for specific others. *PLOS ONE* 13, 8 (Aug. 2018), e0202442. https://doi.org/10.1371/journal.pone.0202442 Publisher: Public Library of Science.

[49] Qiner Lyu, Kentaro Watanabe, Hiroyuki Umemura, and Akihiko Murai. 2023. Design-thinking skill enhancement in virtual reality: A literature study. *Frontiers in Virtual Reality* 4 (April 2023). https://doi.org/10.3389/frvir.2023.1137293 Publisher: Frontiers.

[50] Christoph Meinel, Larry Leifer, and Hasso Plattner (Eds.). 2011. *Design Thinking*. Springer Berlin Heidelberg, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-13757-0

[51] Bennet B. Murdock Jr. 1962. The serial position effect of free recall. *Journal of Experimental Psychology* 64, 5 (1962), 482–488. https://doi.org/10.1037/h0045106 Place: US Publisher: American Psychological Association.

[52] Galia Novakova Nedeltcheva and Elena Shoikova. 2017. Coupling Design Thinking, User Experience Design and Agile: Towards Cooperation Framework. In *Proceedings of the International Conference on Big Data and Internet of Thing*. ACM, London United Kingdom, 225–229. https://doi.org/10.1145/3175684.3175711

[53] Alfred Oti and Nathan Crilly. 2021. Immersive 3D sketching tools: Implications for visual thinking and communication. *Computers & Graphics* 94 (Feb. 2021), 111–123. https://doi.org/10.1016/j.cag.2020.10.007

[54] Tabitha C. Peck and Mar Gonzalez-Franco. 2021. Avatar Embodiment. A Standardized Questionnaire. *Frontiers in Virtual Reality* 1 (Feb. 2021). https://doi.org/10.3389/frvir.2020.575943 Publisher: Frontiers.

[55] Luis Pinto-Coelho, Anna Laska-Leśniewicz, Elizabeth T. Pereira, and Joanna Sztobryn-Giercuszkiewicz. 2023. Inclusion and adaptation beyond disability: Using virtual reality to foster empathy. *Medycyna Pracy* 74, 3 (Sept. 2023), 171–185. https://doi.org/10.13075/mp.5893.01386

[56] Jayne Pivik, Joan McComas, Ian MaCfarlane, and Marc Laflamme. 2002. Using Virtual Reality to Teach Disability Awareness. *Journal of Educational Computing Research* 26, 2 (March 2002), 203–218. https://doi.org/10.2190/WACX-1VR9-HCMJ-RTKB

[57] Plattner, Hasso. 2010. An Introduction to Design Thinking Process Guide. https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf

[58] Qunatum. 2022. Medic Bundle. https://assetstore.unity.com/packages/3d/characters/humanoids/humans/medic-bundle-230116

[59] Jaziar Radianti, Sofie Wass, Marianne Hovet Steig, and Mugula Chris Safari. 2024. Exploring Immersive VR-based Emphatic Learning Using Interpersonal Reactivity Index. https://doi.org/10.24251/HICSS.2024.637

[60] Rim Razzouk and Valerie Shute. 2012. What Is Design Thinking and Why Is It Important? *Review of Educational Research* 82, 3 (Sept. 2012), 330–348. https://doi.org/10.3102/0034654312457429 Publisher: American Educational Research Association.

[61] Francisco Rebelo, Paulo Noriega, Emília Duarte, and Marcelo Soares. 2012. Using Virtual Reality to Assess User Experience. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 54, 6 (Dec. 2012), 964–982. https://doi.org/10.1177/0018720812465006

[62] Nicola S. Schutte and Emma J. Stilinović. 2017. Facilitating empathy through virtual reality. *Motivation and Emotion* 41, 6 (Dec. 2017), 708–712. https://doi.org/10.1007/s11031-017-9641-7

[63] Valentin Schwind, Pascal Knierim, Cagri Tasci, Patrick Franczak, Nico Haas, and Niels Henze. 2017. "These are not my hands!": Effect of Gender on the Perception of Avatar Hands in Virtual Reality. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, Denver Colorado USA, 1577–1582. https://doi.org/10.1145/3025453.3025602

[64] Valeriia Skibina and Victor Taratukhin. 2022. Towards to Extended Empathy Methods in Design Thinking. In *Information Systems and Design*, Victor Taratukhin, Mikhail Matveev, Jörg Becker, and Yury Kupriyanov (Eds.). Springer International Publishing, Cham, 323–335. https://doi.org/10.1007/978-3-030-95494-9_27

[65] Martin Stancek, Ivan Polasek, Tibor Zalabai, Juraj Vincur, Rodi Jolak, and Michel Chaudron. 2024. Collaborative software design and modeling in virtual reality. *Information and Software Technology* 166 (Feb. 2024), 107369. https://doi.org/10.1016/j.infsof.2023.107369

[66] Universfield. 2023. Hospital Monitor. https://pixabay.com/sound-effects/hospital-monitor-151929/

[67] Valem Tutorials. 2023. Complete VR Body Setup - Arms and Legs IK with Hand Animation. https://www.youtube.com/watch?v=v47lmqfrQ9s

[68] Thomas Waltemate, Dominik Gall, Daniel Roth, Mario Botsch, and Marc Erich Latoschik. 2018. The Impact of Avatar Personalization and Immersion on Virtual Body Ownership, Presence, and Emotional Response. *IEEE transactions on visualization and computer graphics* 24, 4 (April 2018), 1643–1652. https://doi.org/10.1109/TVCG.2018.2794629

[69] Wang. 2024. Enhancing higher education art students' learning experience through virtual reality: a comprehensive literature review of product design courses. *Interactive Learning Environments* 32, 10 (2024), 7399–7415. https://doi.org/10.1080/10494820.2024.2315125 Publisher: Routledge.

[70] Deborah Wingler, Anjali Joseph, Sara Bayramzadeh, and Andrew Robb. 2020. Using Virtual Reality to Compare Design Alternatives Using Subjective and Objective Evaluation Methods. *HERD: Health Environments Research & Design Journal* 13, 1 (Jan. 2020), 129–144. https://doi.org/10.1177/1937586719851266

[71] Eun Kyoung Yang and Jee Hyun Lee. 2020. Cognitive impact of virtual reality sketching on designers' concept generation. *Digital Creativity* 31, 2 (April 2020), 82–97. https://doi.org/10.1080/14626268.2020.1726964

[72] Michael Yin and Robert Xiao. 2024. How We See Changes How We Feel: Investigating the Effect of Visual Point-of-View on Decision-Making in VR Environments. *Proceedings of the ACM on Human-Computer Interaction* 8, CSCW2 (Nov. 2024), 1–27. https://doi.org/10.1145/3686933

[73] José P. Zagal and Sebastian Deterding (Eds.). 2018. *Role-Playing Game Studies: Transmedia Foundations* (1 ed.). Routledge, New York: Routledge, 2018. https://doi.org/10.4324/9781315637532

[74] Jingjing Zhang, Ze Dong, Xiaoliang Bai, Robert W. Lindeman, Weiping He, and Thammathip Piumsomboon. 2022. Augmented Perception Through Spatial Scale Manipulation in Virtual Reality for Enhanced Empathy in Design-Related Tasks. *Frontiers in Virtual Reality* 3 (April 2022). https://doi.org/10.3389/frvir.2022.672537 Publisher: Frontiers.

APPENDICES

Appendix A

Study Materials

A.1 Information Letter

Study Title: Switching Perspectives in Virtual Reality: Understanding Users

Principal Investigator Dr. Oliver Schneider Management Science and Engineering University of Waterloo, Canada oliver.schneider@uwaterloo.ca

Co-Principal Investigator Dr. Cayley MacArthur Stratford School of Interaction Design and Business University of Waterloo, Canada cayley.macarthur@uwaterloo.ca

Student Investigator Jieun Lee System Design Engineering University of Waterloo, Canada jieun.lee@uwaterloo.ca

To help you make an informed decision regarding your participation, this letter will explain the study, the possible risks and benefits, and your rights as a research participant. If you need help understanding something in the letter, please ask the investigator before agreeing to participate in the study.

Study Overview

You are invited to participate in a research study about experiencing/switching different perspectives in VR to understand the user's experience. This is important as it can provide insights into how VR could further be used as a tool for UX, showing the importance of incorporating perspectives. This research is a Master-level thesis study.

What will you be asked to do

As a participant, you will be filling out a demographic and pre-questionnaire, asking your age, gender, education and etc., before experiencing a scenario through a user's perspectives. You will be asked to view, interact, and experience the user scenarios using VR equipment as a researcher to identify and understand user needs and problems. After the condition, you will be asked to fill out a questionnaire about the findings on the user experience and their own experience. Once all conditions are completed, there will be a

closing interview for approximately 20 minutes. With consent, you will be audio, video, and screen recorded during these sessions.

For questionnaires, you will be using Qualtrics that has implemented technical, administrative, and physical safeguards to protect the information from loss, misuse, and unauthorized access, disclosure, alteration, or destruction. However, no Internet transmission is ever fully secure or error-free. Some questionnaire would be on paper which will be stored in a locked office in University of Waterloo.

Scenario

The scenario depicts an emergency room showing the hospital environment with patients and medical staff. There is no depiction of any graphic medical procedures, blood, or serious injuries. The focus is on understanding user experiences in the emergency rather than portraying medical trauma. However, we acknowledge that hospital environments may be sensitive for some individuals. Participants are free to not continue, pause or withdraw from the study without any consequence by talking to the researchers.

Participation

To be eligible for participation in the study, you need to be 18 to 64 years old, have working knowledge on UX design and research with no history of severe motion sickness to VR and vision impairments. You must have normal or corrected-to-normal vision. Your involvement in this study is voluntary, and it will require approximately 60 minutes of your time. You have an option to decline to answer any questions during the study if you choose to do so. Additionally, you have the right to withdraw from the study at any time without facing any consequences. You can request that your data be removed from the study at any point in time, but it is impossible to withdraw your data once papers and publications have been submitted to the publisher. As an appreciation for your valuable contribution to this research, you will receive $20 gift card. This amount may be taxable. It is your responsibility to report this for income tax purposes.

Risks to Participation in the Study

Due to the study design, where participants use VR equipment, there is a potential for feeling unwell due to cybersickness – dizziness, nausea, and headaches. However, the

research is designed so that there will be frequent breaks from wearing a VR headset to mitigate this risk. If needed, participants can request breaks from the usage of VR by simply alerting and talking to the researcher.

Benefits of the Study

This research hopes to contribute by showing an interaction technique for switching different perspectives and the results from the user study comparing 1st, 2nd user perspectives and switching between them for how people understand user problems and

experiences. The work hopes to provide findings on the importance of incorporating this interaction technique, the ability to switch perspectives, because it gives researchers a fuller, complete experience to empathize and understand users better. We ultimately hope to show how VR could be used further as a tool to aid researchers in UX process and expand its use cases, helping it to take the crucial first step in UX; understanding users.

Confidentiality and Security of Data

The data collected will be confidential through assigning participant ID. The data will only be used for this study to answer research questions. Due to this, your personal identification will not be used in any reports related to this research. With permission, anonymous quotes will be used alongside participant ID (ex. P1, P2). Any facial images of the recordings will be blurred when they are in use with publication. The collected data will be securely stored on a password-protected computer and on a secured OneDrive and in a locked office for a minimum 7 years and will be destroyed afterwards.

This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board (REB #47283). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1- 833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca. For all other questions regarding this research study, please feel free to contact any member of the research team listed on this form

If you have any questions regarding this study or would like additional information to assist you in reaching a decision about participation, please get in touch with Jieun Lee by email at jieun.lee@uwaterloo.ca.

A.2 Consent Form

Participant Consent Form

By signing this consent form, you are not forfeiting your legal rights or absolving the investigator(s) or associated institution(s) from their legal and professional obligations.

I have thoroughly reviewed the information presented in the information letter about the research conducted by graduate student Jieun Lee from System Design Engineering at the University of Waterloo. I have had the opportunity to ask questions related to the study and have received satisfactory answers and any additional details.

I have had a chance to inquire about any questions, concerns, and comments related to this study, acquired adequate responses, and received needed information. I was informed that participation in the study is voluntary and that I can withdraw this consent and any limitations to this withdrawal by informing the researcher.

I acknowledge that participation in the study entails video/audio/screen recording to ensure accurate captures of my behaviours and responses. Facial features will be blurred for anonymity if the video recordings are used in any thesis, publication, or videos that comes from this research. Additionally, I understand that the responses to the questionnaire and interview may be included in the thesis and/or publications, with anonymous quotes with only participant ID.

Only researchers associated with this study will have access to the data which are secured in a password-protected computer. The data will be kept for 7 years and be destroyed afterward. Within this time, you can contact the researchers to withdraw your consent from the study and ask for your data to be destroyed. However, it is not possible to withdraw if papers and publications have been submitted to publishers. All data will be destroyed according to University of Waterloo policy.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #47283). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca. If you have any questions regarding this study, you can also contact the student investigator, Jieun Lee at jieun.lee@uwaterloo.ca.

By providing your consent, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

Please mark one of the following:

[] I agree to participate in this study

[] I do not agree to participate in this study

I agree to have both my behaviours inside and outside of VR, and interview be audio/video/screen recorded.

[] I agree

[] I do not agree

I agree with the use of the video recording with blurred features for anonymity in any thesis, publication, or video that comes from this research.

[] I agree

[] I do not agree

I agree with the use of anonymous quotations in any thesis or publication that comes from this research.

[] I agree

[] I do not agree

A.3 Questionnaire

Likert-Scale Questionnaire

Please respond to the following statements on a 7-point scale, where: 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree.

1. I feel user frustration.
2. I understand user frustration.
3. It was easy to feel connected to the situations and user stories presented in the emergency rooms scenario.
4. It was easy to understand the situations and user stories presented in the emergency room scenario.
5. Seeing the user scenario from this perspective was helpful to understand user experience.
6. I believe seeing the user scenario from this perspective deepen my understanding.
7. I am confident that I found most user needs and problems.
8. I feel empathetic toward the user whose perspective I experienced.
9. I feel empathetic toward the users I observed in the experience.

Open-ended Questionnaire

1. Please list all the user problems, pain points, frustrations you noticed during the scenario.

2. Please list all the user needs, wants, and motivations you noticed during the scenario.

3. Based on the scenario you experienced, if you were asked to identify a specific area or problem within the emergency room to improve through research or design, what would you focus on, and why?

4. After experiencing the scenario from the user's perspective, what solutions can you propose/ideate to address the problems you noticed? Feel free to list, describe, or sketch as many ideas as you like.

A.4 Feedback Letter

Project Title: Switching Perspectives in Virtual Reality: Understanding Users

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We want to thank you for your valuable participation and interest in the study! We appreciate you dedicating your time to this research.

The purpose of this study was to introduce the switching perspective interaction technique to understand user needs and problems in UX research/design. Numerous studies have discussed VR's ability to be a tool in UX research/design due to its perspective-taking ability, being able to experience someone else's shoes. However, the consequences of being able to manipulate the perspectives are understudied, such as being able to switch from 1st person and 2nd person in the user stories. Therefore, we investigate this to reveal insights on how switching perspectives aids one's understanding of the user compared to experiencing only one perspective. We ultimately hope to show how VR could be used

further as a tool to aid researchers in UX process and expand its use cases, helping it to take the crucial first step in UX; understanding users.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #47283). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca.

If you have any questions or comments, please contact the student investigator, Jieun Lee, at jieun.lee@uwaterloo.ca. Additionally, you can contact the same email if you are interested in the result of this study when they are published. Thank you again.

A.5 Resources for Switching Perspective Interaction Technique

License-free online sources were used to create the VR scenario. The audio sources [14, 18, 17, 66] and Unity Assets [24, 58, 38, 25] were used for setting up the virtual environment with background audio. One tutorial on YouTube where a Unity C# script was modified for this project [67]. All sources cited in this appendix are listed in the References section.