Cohabitant: The Design, Implementation, and Evaluation of a Virtual Reality Application for Interfaith Learning and Empathy Building

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ABSTRACT

Lack of interfaith communication often gives rise to prejudice and group-based conflict in multi-faith societies. Nurturing this communication via interfaith learning may reduce this conflict by fostering interfaith empathy. HCI has a dearth of knowledge on interfaith coexistence and empathy building. To address this gap, we present the design, implementation, and usability of *Cohabitant*: a virtual reality (VR) application that promotes interfaith learning and empathy. *Cohabitant*'s design is theoretically underpinned by Allport's intergroup contact theory and informed by insights from a participatory workshop we ran with members of three religious groups: Christians, Hindus, and Muslims. Our evaluation study, combining quantitative and qualitative data from 30 participants, suggests that *Cohabitant* may enhance general interpersonal empathy, but falls short for ethnocultural empathy. We discuss the possible design and policy implications of using this kind of VR technology for interfaith learning and empathy building.

CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools**; *Usability testing*.

KEYWORDS

Interfaith; Virtual Reality; Learning; Empathy

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1 INTRODUCTION

Recent years have seen an alarming increase in conflict between faith-based groups [31]. According to a Pew Research Center survey, one-third of 195 countries have experienced high levels of religious hostilities [31]. These hostilities manifest in various forms, including discrimination against minority religious groups [106], religious-based homophobia [106], anti-Semitism and anti-Sikhism [36, 98], Islamophobia [2], and even state violence rooted in religious conflicts [14, 41]. Studies in psychology, peace-building, and interfaith communications identified theological [118, 119, 122] and socio-cultural [64, 97, 155] reasons for such violence, detailing prejudice, misinformation, stereotypes, propaganda, and a lack of learning as leading antecedents [3, 110, 172]. Additionally, in a globalized and increasingly secular world, misunderstandings about religious "others" [147], often exacerbated by precarious political interests [3, 4], are commonplace. This has led to a significant academic focus on breaking down faith-specific stereotypes across various domains.

A popular approach involves promoting interfaith dialogues, bringing together faith leaders, organizations, and activists to engage in meaningful conversations [1, 52, 65, 87, 150, 180]. While some initiatives have been successful in certain macro-social settings [120], others have required more nuanced methods in the micro-social settings [15, 121, 161]. In response to these varied

needs, interfaith exposure and learning have emerged as effective approaches for intergroup communication and peace building [120].

HCI has a longstanding history of utilizing various interactive platforms, including Augmented Reality (AR) and Virtual Reality (VR), to promote interactive learning environments that address cultural differences. For our purposes, research in cultural heritage education [33, 148], well-being and mindfulness [125, 165, 174], collaborative engagement [6, 80, 178], and prosocial behavior [146, 151, 188] offers an intellectual foundation for applying these technologies in the context of interfaith dialogue and learning. For example, by immersing users in a different environment or allowing the user to co-exist in virtual spaces with others (so-called presence and co-presence), VR enables the sharing of perspectives and experiences. This facilitates the user's learning of new information [13, 170].

However, existing racial and power imbalances, as well as the fear of social persecution when engaging with religious "others", mean that interfaith dialogue is an enterprise riddled with logistical and ideological challenges [46, 75, 94, 121]. Albeit still a nascent space, a small body of work in the religion-focused HCI literature highlighted a need for a sensitive and nuanced understanding of communal ethics and the creation of an environment of mutual learning between designers and religious groups when building effective technology-mediated support [112, 140, 141]. One way to re-create this communal element is via capitalizing on the virtual "presence" of religious "others" that VR can bring. The VR environment provides a safe space for users to observe unfamiliar cultures and engage with normally inaccessible groups in a physical (through spatial movements, which we capture using role-playing activities) or sensorial way (through vision and audio, which we capture using storytelling techniques) [57, 81, 156]. It is worth noting that we are not suggesting VR as the sole (or best) modality for achieving interfaith learning and empathy building. Rather, we simply investigate its potential as an effective tool for achieving this goal. In this paper, we aim to advance the HCI literature on religion and intergroup coexistence and demonstrate VR's potential role in reducing faith-based conflicts and promoting interfaith dialogue.

To this end, we develop and test *"Cohabitant"*, a VR application designed to enhance interfaith learning and empathy. For its design, we draw inspiration from Gordon Allport's contact theory [4] as well as glean insights from Christians, Hindus, and Muslims who took part in our participatory design workshop. *Cohabitant* uses storytelling and role-playing to immerse its users in a day of celebration specific to each of these three religions. We tested its usability and impact on empathy with 30 participants (10 from each religion) using both quantitative and qualitative methods. Our findings indicated that participants felt greater interpersonal empathy after using *Cohabitant*, but decreased feelings of ethnocultural empathy. Our work makes the following contributions to HCI:

- We present the design, implementation, and development of *Cohabitant*, a VR application for interfaith learning and empathy building.
- We present our findings from an evaluation study of *Cohabitant* using 30 participants, 10 from each of the Christian, Hindu, and Muslim groups. We examine the potential and limitations of using VR to generate interfaith empathy and learning given these findings.
- We conduct a qualitative analysis of semi-structured interviews, and use these insights to make design recommendations for more effective interfaith connection, learning, and empathy building.

2 LITERATURE REVIEW

In this section, we draw from three areas of scholarship to inform *Cohabitant*: religious group conflicts and coexistence, interfaith learning and dialogue, and the use of VR for learning and empathy building. In the next section, we build on Gordon Allport's contact theory to outline design components for *Cohabitant*.

2.1 Religious Affect in Group Coexistence

Conflicts and coexistence among religious groups have been widely studied, covering theological differences and sociopolitical factors that contribute to interfaith tension. Historically, religion has influenced conflicts on both micro-social and global scales [74], often generating prejudice and stereotypes among faith-based groups [74]. Discrimination against religious groups varies in form and intensity across different faiths. For example, in Eastern and Western Europe and the U.S., prejudice against Muslims is notably high [84, 166], while in some South Asian regions, Hindus face more discrimination [82, 113]. Additionally, negative attitudes toward religious outgroups are not confined to fundamentalists; they also appear among those with lower levels of fundamentalism, those with no religious affiliation, and are even independent of political orientation [27, 28]. Further, people with both traditional and liberal worldviews tend to protect their beliefs by utilizing prejudices [26]. Altogether, this body of research investigates the structures and underlying causes of inter-religious conflicts, while also offering insights into the coexistence of religious groups.

A key factor in prejudice is how religious teachings and affiliations shape intergroup attitudes [74]. Religious identities also profoundly affect ethno-religious connections due to their widespread influence [83]. Given that religious institutions hold moral authority and represent a large segment of the global population [140], they play a vital role in forming ethnic identities. This intertwining of faith and ethnicity, combined with faith-based stereotypes, can lead to ethno-religious conflicts, known as ethnodoxy [86]. These dynamics persist even in secular settings, underlining religion's enduring impact on group relations and coexistence.

2.2 Outcomes and Challenges of Interfaith Connection and Learning

While HCI hasn't directly tackled interfaith issues, conflict and peace studies, along with religious studies, emphasize dialogues and connections between faith-based groups for learning and empathy building. The key aim of interfaith learning is fostering meaningful relationships and empathy among religious groups, highlighting diverse perspectives and addressing social biases that hinder harmony [20, 29, 87, 187]. The goal of these approaches is to transform attitudes towards other faiths by building trust and sharing intimate beliefs, leading to shared identity, improving inter-religious attitudes, and fostering pluralism [54, 107, 134]. Interfaith learning also yields long-term benefits like promoting gender equity, peace,

justice, fostering tolerance, and improving communication in multi-faith contexts [15, 48, 179]. However, successful outcomes require addressing power imbalances, engaging in participatory learning, and developing a common language for discussions [25, 46, 54, 54]. We draw on these insights, exploring religious group similarities and differences through participatory design workshop, and applying cautious approaches in experiments and immersion to avoid potential negative outcomes.

2.3 Using VR for Learning and Empathy

VR and AR technologies are increasingly used in HCI to enhance real-world interactions and learning, particularly in challenging logistical or historical contexts. They support various applications, such as fostering civic engagement in activism [162], reducing mental health stigma [171, 176], and facilitating intercultural heritage learning [148]. Recent HCI research has been exploring how these technologies can augment learning, knowledge exchange, and empathy. Examples include VR applications that foster empathy towards Fukushima evacuees [92], refugees [91], and encourage environmental awareness [165]. These studies also focus on reducing dehumanization of outgroups [49], dismantling gender stereotypes [114], and aiding in understanding complex conditions like schizophrenia and dementia [18, 164]. Key elements in these applications are immersive role-playing, reflective engagement, and user interaction, with careful consideration of immersion levels and context for effective empathy development [79, 92, 114]. These approaches of using VR have inspired similar techniques for fostering interfaith learning and empathy. We build on this literature and join the growing HCI literature on measuring empathy levels in VR interactions to enhance their effectiveness and impact [49].

A subset of HCI literature cautions about potential pitfalls in VR-based empathy interventions. Poorly designed VR technologies could inadvertently exacerbate the stigma that marginalized groups already face [17, 173]. It is also crucial to account for variations in empathy constructs to ensure reliable and accurate measures [30]. Additionally, the lack of a shared vocabulary among designers of empathy tools hampers effective comparison across different technologies [136]. Concerns have also been raised about unintended consequences when using these technologies to promote prosocial behavior [96]. Establishing the transferability of self-reported empathy scores from VR settings to real-world scenarios remains a challenge [30]. We recognize the caution against using VR for empathy-building in addressing deep-rooted social justice issues, as it may foster a "toxic" form of empathy [115]. Additionally, research on evaluating VR's long-term impact on empathy is still evolving [163]. In designing *Cohabitant*, we are mindful of these critiques and the possibility that empathy developed might be transient. We also acknowledge the ethical dilemmas in using VR for interfaith contact, which could extend to other socio-technical mediums for connecting faith-based groups.

3 DESIGN AND IMPLEMENTATION OF *COHABITANT*

Cohabitant is an immersive VR application that simulates a religious day of celebration in any one of three religions. These simulations allow users to experience and engage in faith-based activities that are distinct from those of their own faith. *Cohabitant* integrates elements such as attire, food, rituals, and games, accompanied by a pre-scripted audio guide narrating each element's cultural and religious significance, with immersive role-playing and storytelling techniques to achieve its goal. This section details the development and implementation of *Cohabitant*. We start with a description of Gordon Allport's contact theory [4, 5, 126] and then discuss the participatory design workshop we held to gather information regarding the aforementioned design elements.

3.1 Theoretical Framework

3.1.1 Intergroup Contact Theory. In "The Nature of Prejudice," Gordon Allport introduced intergroup contact theory, suggesting that prejudice among various ethnic, racial, and social groups arises from misconceptions and stereotypes, and can be mitigated through interactions and mutual learning [4]. He identified four "ideal" conditions for effective intergroup contact: equal status among groups, shared objectives, cooperative interactions, and supportive authority [4, 126]. Although critiqued for oversimplifying complex social dynamics, ignoring power imbalances, and relying heavily on these "ideal" conditions [89, 129, 130], the theory has found widespread application over the last five decades and effectiveness in promoting intergroup understanding and harmony, even in non-ideal conditions [72]. It has been tested across various user groups, settings, and contexts, evolving to include subtheories like extended, imagined, and secondary contact [43, 68, 111, 157, 186, 197]. Closer to our interest, a practical example is in Northern Ireland, where interaction between Protestants and Catholics facilitated trust and empathy [67], demonstrating the theory's adaptability and relevance across diverse domains.

3.1.2 Contact Theory and Mechanisms for Building Connections and Empathy. Drawing from a meta-analysis by Pettigrew and Tropp [128], three primary ways emerge through which intergroup contact reduces prejudice: (a) improving outgroup knowledge, (b) easing intergroup communication anxiety, and (c) nurturing empathy and perspective-taking. We are particularly interested in the interplay between intergroup contact theory and empathy, which often intersects with diverse facets of intergroup learning and communication. Studies in Psychology on intergroup contact identify four states of empathy: two involve perspective-taking, where one imagines the thoughts and feelings of an outgroup member, and the other two involve feeling as an outgroup member and considering their perceptions about one's own group, known as the "imagine-other" perspective [16]. This literature suggests that assuming another's perspective fosters cognitive processes that enhance social coordination and reduce stereotypes [50]. Perspective-taking, which includes both conscious (e.g., feeling sympathy) and unconscious mechanisms, helps discover commonalities and reduces prejudice [40]. Social psychology studies further show that adopting outgroup perspectives can dismantle stereotypes, increase liking, and foster empathy towards that outgroup [184]. For instance, Vescio et al. found greater empathy and favorable attitudes towards African Americans when participants assumed their perspective [184]. Similarly, Shih et al. reported increased tendencies to help Asians after taking an Asian individual's perspective [160].

These findings reveal how empathy in intergroup contexts can promote positive relations, highlighting the importance of perspective-taking in understanding and improving intergroup dynamics.

3.1.3 Design Component: Storytelling. Perceived threats and anxiety between groups often lead to conflict and discrimination [138, 154]. Storytelling, by sharing traditions and cultures, can reduce these threats and foster appreciation for diversity [76]. It involves constructing and sharing narratives that shape knowledge, memories, and identity [108, 135]. This process enables people from different groups to understand each other's experiences and perspectives, fostering empathy and reducing bias [69, 103]. As a versatile tool, storytelling has been employed in various academic domains to enhance intergroup communication, establish commonality, and promote reconciliation [32, 63, 99]. Because of this mechanism's capability to increase affective learning, perspective taking, and empathy [44, 143, 145], we have utilized this as a design component of *Cohabitant*.

3.1.4 Design Component: Role-playing. Role-playing in interactive environments, like VR, allows people to experience and embody different perspectives, enhancing empathy and perspective-taking [47, 60]. Studies show that role-playing in VR can evoke emotions similar to those in real scenarios, influencing real-world behaviors [104]. For example, VR role-playing games increased spatial presence and empathy among nursing students and heightened the likelihood of adopting another's perspective in "day-in-the-life" simulations [182]. In contexts like bullying in schools, role-playing led to more morally sound attitudes and increased willingness to support others [58]. By embodying others' experiences, role-playing serves as an effective tool for empathic learning and building relationship [34, 53, 182, 183].

Furthermore, in the context of school bullying, role-playing games resulted in participants having more morally correct opinions about bullying, a higher willingness to engage in supportive behaviors towards others, and an increased feeling of empathy [58]. In these ways, role-playing allows the body to be used as an instrument to embody others' subjective reality. As such, it enables perspective-taking and empathic relationship building [34, 53, 183].

3.2 Participatory Design Workshop

To ethically and accurately collect stories to generate a "script" for *Cohabitant*, we held a participatory design workshop with members from the three religious groups. Using word of mouth and then snowball sampling [55], we recruited six participants in two phases. In the first phase, we recruited one Christian male, one Hindu male, one Hindu female, and one Muslim male to participate in an in-person workshop to generate the initial stories. In the second phase, we recruited one Christian female and one Muslim female, who reflected on the generated stories in the first phase and added additional cultural, ritualistic, and gendered perspectives[1].

There are several rationales for our focus on Christianity, Hinduism, and Islam as the three religions, as well as our recruitment of laypeople for the workshops. First, our choice of faiths was based on the geographic location and religious diversity of our research site. It is possible that had we selected a different set of religions, our research outcomes may have differed. Nevertheless, our core objective remains to explore VR's potential in fostering interfaith learning and empathy, and this objective does not prescribe a focus on any specific faith. Second, we chose to engage with non-experts (laypeople) for our workshop and user study in order to authentically capture the average experience of a religious festival. We wanted to create VR simulations that would resonate with a layperson by reflecting a typical, first-person experience of the event. In contrast, experts such as religious leaders or scholars have unique religious roles and perspectives that may not be scalable. For example, religious leaders are particularly high in affective empathy and are focused on spiritual growth of others [7, 100]. This may lead them to inadvertently curate experiences which emphasize persuasive elements. This introduces bias. Our objective is not to promote any religion, but to facilitate immersive and relatable experiences. Using non-expert narratives helps us do that.

3.2.1 The Workshop Goals, Procedures, and Activities. Because one of our goals was to measure whether immersion in *Cohabitant* increased participants' empathy, we standardized the content of each religious scenario to control for irrelevant variables that might bias participants' responses. To do this, we selected the same theme for each of the three religious scenarios: the celebration of a major religious holiday. Instead of pre-selecting the religious festivals, we asked participants at the beginning what their choice of religious festival would be. The Hindu participants selected Durga Puja; Muslim participants selected Eid-ul-Fitr; and Christian participants selected Easter[2]. The participants selected the stories based on their culture and spontaneity of participation in these festivals. While the Hindu and Muslim participants did not have any confusion in choosing their festival, the Christian participant hesitated for a moment to choose between Christmas and Easter, and finally settled with Easter.

We then asked each participant to provide written descriptions (in English), as well as any pictures or videos found online or personally taken, of any artifact, ritual observation, or moments of celebration from what a typical "day-in-the-life" would be like for somebody celebrating a major religious festival in their faith. As guidance, and to ensure standardized design across all our eventual VR environments, we asked participants to follow a chronological timeline that begins at the time they would wake up in the morning, to when the final celebrations wrap up at the end of the day. To further ensure cross-design standardization, we encouraged participants to particularly elaborate on the role that (1) Attire, (2) Food, (3) Gifts, (4) Games, and (5) Rituals played in their festival celebrations. For each item, participants were instructed to, where applicable, answer questions regarding what the item looks like; how one would engage with it; who it would be offered to; how its use differs between children and adults; what specific rules or movements may be associated with it; the item's personal, cultural, or historical significance to the festival, as well as any other important details. Maintaining consistency in the types of items across

[1]Table 1 provides an overview of all the participants at different stages of this study. Participants from one stage of the study did not participate in another stage. For example, the workshop participants did not take part in the user study phase.

[2]Easter [191], Durga Puja [190], and Eid [192] are the most celebrated religious festivals in Christianity, Hinduism, and Islam respectively.

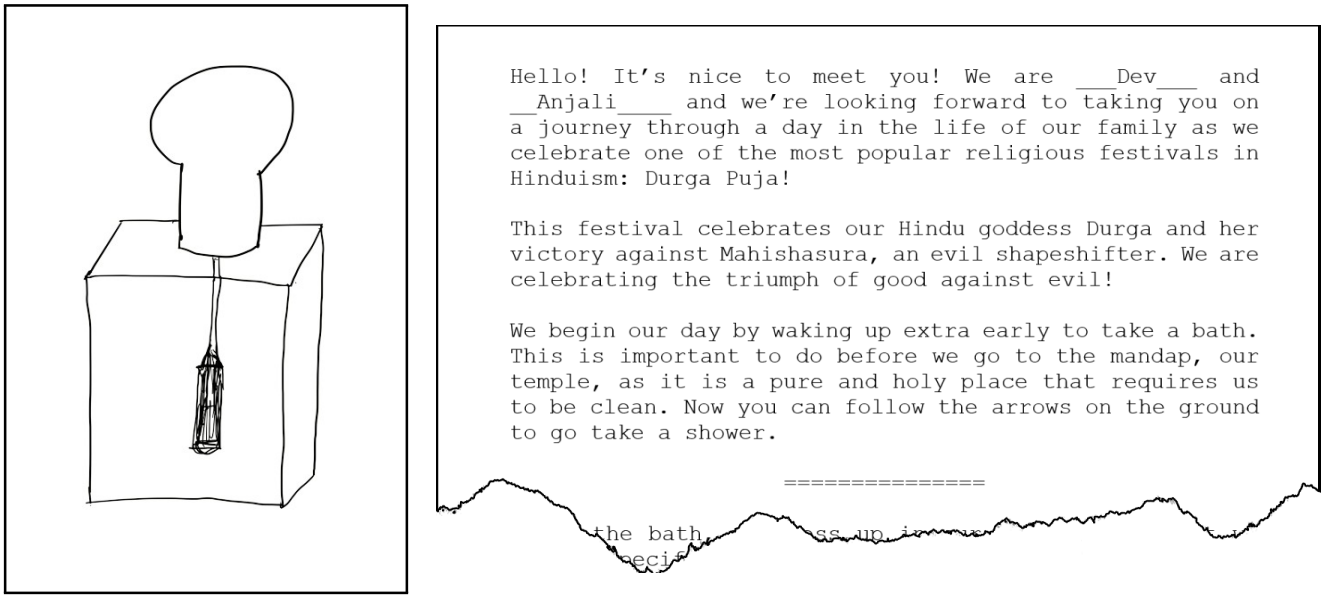

Figure 1: (left) One of our Muslim participants from the participatory design workshop drew a picture of an "aatar" bottle. Aatar is a type of natural perfume. This drawing evoked the participant's childhood memories of attending Eid prayers with his father in his home country. (right) An excerpt of the VR script from the Hinduism scene.

the three faiths allowed us to better control the evaluation study. Due to this consistency, any observed changes in empathy among participants can be more directly attributed to the types of items they observed or their "interactions" in the role-playing scenarios, rather than the possibility that certain faiths included more or fewer empathy-generating elements. Participants were also encouraged to manually draw these items to help us ensure that the assets we use in *Cohabitant* resemble as closely as possible the objects that the participants envisioned.

We then conducted a second, subsequent session where each participant exchanged their faith story with the rest of the group. Participants briefly narrated their typical day of celebration and were encouraged to discuss whether their faiths typically allowed for people of different faiths to observe and/or partake in faith-specific activities and rituals. Participants differentiated between cases where there was communal hesitation and those that were more accessible. The goal of this second session was to identify these moments of hesitation, reservations, and cultural and religious sensitivities so that they could be bypassed in the design of *Cohabitant*.

We also audio recorded the design workshop and collected pictures and drawings from the participants for further analysis. Combined with the written descriptions, we used this information to generate our religious scripts.

3.2.2 Generating Scripts from the Workshop. To capture the two elements of storytelling and role-playing in our VR environment, we first used the workshop participants' responses regarding the personal, cultural, and historical significance of the various elements of the festival to create a story-line script for each faith. This, in addition to the chronological nature of the day-in-the-life set-up, provided an effective template for storytelling. Then, we inserted into each script opportunities for the participant to physically engage with the VR environment (i.e., to role-play). For example, depending on the faith condition, participants are instructed to use the VR set's grab-and-hold features to put on traditional clothes, offer gifts to children, or offer food to deities (if they feel appropriate). They can also use the same feature to grab objects (such as "Thal" in the Hinduism scene) to take a closer look at them. We also added some religiously significant auditory features for each religion: a mantra in the Hinduism scene; a hymn in Christianity; and a Quranic recitation in Islam. As with the narrative scripts we created, the nature and content of these role-playing opportunities were informed by our workshop participants' responses.

Post-script completion, we created voice recordings for each script to be superimposed onto the corresponding VR environment. For example, we superimposed the Hinduism script's audio recording on the Hinduism VR environment, and so on. *Cohabitant* is therefore the combination of these three VR scenes in which participants are guided by a storytelling narrator who occasionally instructs and encourages the participant to physically interact with their environment through the performance of certain role-playing actions.

3.3 Implementation Details

We developed the three religious VR scenes using the Unity Game Engine. These applications were deployed on a Meta Quest Pro headset for the user study. Most of the 3D models used in the scenes were sourced online to create authentic settings. During deployment, we optimized and simplified some textures to accommodate the limited computing resources of standalone VR headsets. The controllers were programmed to enable scene navigation, including

walking, turning around, and interacting with objects within the scene. Users were required to wear the headset to access the scenes and utilize the controllers to explore the entire set in VR.

At the start of each scene in our VR application, an audio script and narrator set the exposition. In each scene, users experience a day in a religious festival, beginning with "waking up" in a virtual bedroom and progressing through activities like showering and dressing, guided by storytelling scripts and simple commands for role-playing. Visual cues, like blue arrows, direct users to specific locations, while auditory cues, like alarm and shower sounds, improve the feel of the real environment. The application tracks user location to trigger tasks, such as playing a hymn when approaching a church in the Christian scene. Successful completion of tasks, like interacting with specific items, is verified by the application for activities like eating dates in the Islamic scene or offering food in the Hindu and Christian scenes.

We carried out a pilot usability study with four participants, gathering feedback on user experience and suggestions for improving immersion and role-playing actions. We iteratively incorporated the feedback into *Cohabitant*. Further, we noted possible complexities a participant might face during the study, such as the requirement of taking breaks, drinking water, and troubleshooting simple actions during the immersion, which we later incorporated into our study.

3.4 Authors' Positionality

We must acknowledge that our individual backgrounds and experiences could have impacted this study. The research team consists of members from different religious backgrounds: one author self-identifies as agnostic, another as unaffiliated, and the rest as Muslims. All authors have been living in multicultural and multi-religious settings and have interacted with individuals from various faiths in their personal and professional capacities. We acknowledge that these backgrounds may have influenced both the development of *Cohabitant* and the interpretation of findings, despite our best attempts to mitigate their influence. All authors routinely met during the design, experiment, and analysis phases. They discussed the design decisions for *Cohabitant* and the findings from the user study. Additionally, they resolved any confusion and disagreements through discussion and negotiation, drawing on insights from relevant literature and complying with the ethics guidelines of the first author's institution. Our study obtained ethics approval from the respective institutional ethics board of the authors.

4 USER STUDY

Our user study had a dual purpose: (a) to measure how this contact subsequently affected interfaith learning and empathy building, and (b) to qualitatively investigate the usability of *Cohabitant* and consider its broader implications for using VR and similar interactive technologies to promote interfaith connections, learning, and empathy (section 5.2).

4.1 Psychological Measures

We measured the empathic consequences of the use of virtual reality technology to simulate interfaith contexts using three measures: The Interpersonal Reactivity Index; the Scale of Ethnocultural Empathy; and the Inclusion of Other in the Self scale.

4.1.1 Interpersonal Reactivity Index (IRI). The IRI, a self-report measure in empathy research, evaluates cognitive and affective empathy [38]. Among its four subscales—perspective taking, empathic concern, fantasy, and personal distress—we chose to utilize perspective taking and empathic concern due to their relevance to our research questions. Both the empathic concern and perspective taking subscales of the IRI have a Cronbach's alpha of 0.83, indicating that both subscales reliably measure the underlying construct of interest [88]. Perspective taking involves adopting others' psychological viewpoints, while empathic concern measures feelings of sympathy for those in distress [39]. Participants rated 14 statements, such as "I consider multiple viewpoints in every question" and "Sometimes I don't feel very sorry for other people when they are having problems" on a 5-point Likert scale. The higher the IRI score, the higher the participant's empathy. Relevant statements would be reverse coded accordingly. To avoid participants recognizing that both pre- and post session IRIs were identical, which risks them responding based on memory rather than true feelings, we included 14 decoy items such as "If someone is unhappy, I believe that this is mostly their fault" and "I consider myself a good shoulder to cry on" on each questionnaire. We used different sets of decoy items for the pre- and post-session questionnaire. Furthermore, we included an attention check in each IRI to ensure participants' engagement in the questionnaire.

Most relevant to this project, the IRI has been successfully used in previous research to measure changes in empathy via paired samples t-tests [194], as well as in research investigating the influence of virtual reality on cognitive empathy and perspective-taking [66, 182]. Beyond this, the IRI is the standard measure of empathy in psychology research and has been used to assess this construct in violent offenders [88] and physicians [196]; in the context of mental well-being in the wake of the COVID-19 pandemic [37]; and even to support the use of literary fiction to promote mentalizing abilities [132].

4.1.2 Scale of Ethnocultural Empathy (SEE). The SEE, a self-report scale, measures empathy towards people from different racial and ethnic backgrounds [189]. It comprises four domains: empathic feeling and expression, empathic perspective taking, acceptance of cultural differences, and empathic awareness. Participants used a 6-point Likert scale to indicate their agreement or disagreement with statements like *"I feel annoyed when people do not speak standard English"* or *"I seek opportunities to converse with individuals from diverse racial or ethnic backgrounds about their experiences,"* with relevant statements reverse-coded as needed. In past research, the SEE has been successfully used to assess the multicultural competencies of different individuals in training, such as counsellors working in rehabilitation and graduate and undergraduate students undergoing helping skills training, using methods that included paired-samples t-tests [24, 101, 189]. The SEE has also been translated to different languages (e.g., Turkish) and effectively used in cross-cultural contexts to capture empathy[198]. Taken together, these findings support the scale's applicability to our interfaith study design.

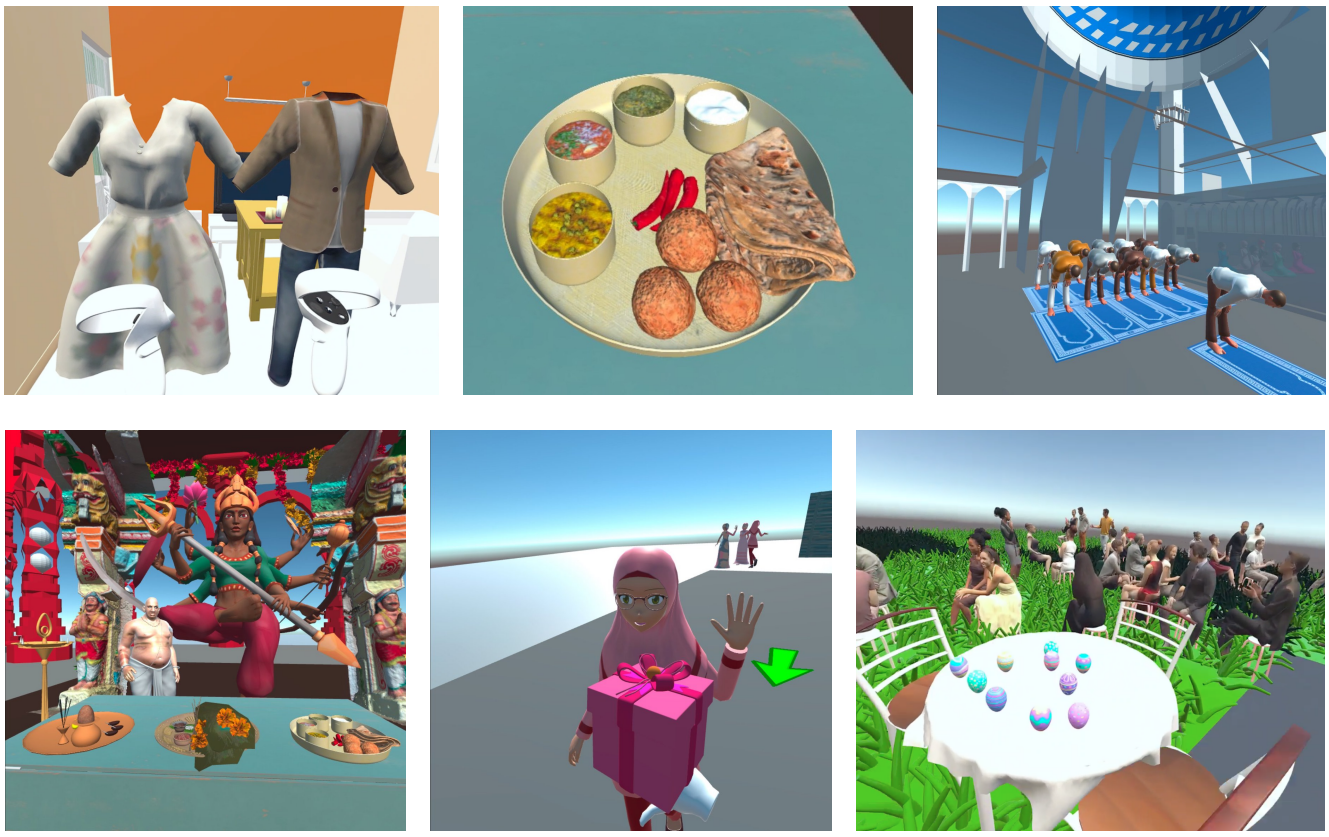

Figure 2: (top-left) Putting on clean clothes before heading to Church on Easter is a morning ritual in the Christian culture. The color and design of the attire carry religious and cultural significance during Easter. (top-middle) "Thal" is an assortment of different, culturally appropriate food items that Hindus eat on the day of Puja. (top-right) Muslims pray in congregation in a mosque or in an open field on the day of Eid-ul-Fitr. (bottom-left) Hindus offer a "Bhoj" [typically a collection of food items] to the deity as part of their religious ritual on the day of Puja. (bottom-middle) Gift-giving, especially to children, is common across all religions, while the types of gifts may vary. (bottom-right) Coloring eggs is a fun activity that some Christians do to celebrate Easter.

Similar to the IRI, we employed SEE as both a pre-test and a post-test questionnaire. A statistically significant difference between the responses collected at each timepoint would suggest an influence of faith-based VR environments on participants' ethnocultural empathy scores. We have included copies of both the IRI and the SEE as supplementary materials to this paper.

4.1.3 Inclusion of Other in the Self scale (IOS). We used IOS – a single-item measure – to assess interpersonal closeness between participants and a person or group of interest[9]. The measure consists of seven diagrams of two circles overlapping to varying degrees and asks respondents to choose the diagram that best describes their relationship with the relevant other, which, in our study, was a person from a different faith. Each diagram is labelled by a number, with the numbers increasing as the diagrams become more overlapped. In other words, the higher the IOS score, the higher the interpersonal closeness.

In the context of intergroup contact, the IOS scale has been used to provide evidence suggesting that feelings of closeness to novel outgroup members predicted respondents' association of these outgroup members with the respondents' sense of self [123]. This, in turn, leads to the formation of cross-group friendships and a sense of shared reality, often termed "merged minds" [71, 124]. Such a sense of unity facilitates the understanding of others' inner states, a key aspect of empathy [45]. Therefore, by assessing whether *Cohabitant* enhances closeness between participants and individuals from different faiths, we can support the use of virtual reality systems in promoting positive intergroup contact experiences.

Similar to the other two questionnaires, we employed IOS as both a pre-test and a post-test measure of interpersonal closeness. A statistically significant difference between the responses collected at each timepoint would suggest that immersion in faith-based VR environments influenced participants' feelings of interpersonal closeness with someone from a different faith.

4.2 Participant Recruitment and Experimental Setup

4.2.1 Recruitment. We recruited 30 participants, comprising 10 Muslims, 10 Christians, and 10 Hindus, through both our school's internal participant pool and snowball sampling [55]. Internal participants received course credit, while others were paid *CAD*30. All participants provided consent to their de-identified data to be collected and used. Some participants also consented to their photos being taken and used. A demographics questionnaire collected gender, ethnicity, and age information. Faith identification relied solely on participants' self-reporting, without the use of proxies, as previous research has cautioned against the reliability of such proxies in assessing religious beliefs [74]. While proxies, such as how often Christian participants go to church or whether Muslim participants pray five times a day, may offer insight into participants' degree of religiosity, this level of detail was not relevant to our research question. Put simply, we are interested in whether the average, self-identifying follower of one religion–regardless of their degree of religiosity–can more easily empathize with the average, self-identifying follower of another religion after experiencing a religious festival from their perspective. Because the aforementioned proxies are not directly relevant to this purpose, it may be paternalistic, and even unethical, to ask participants to elaborate on or justify how little or how much they may adhere to objective expectations of their faiths–expectations that we, as researchers, are not in a position to label or rank.

Importantly, to avoid a host of psychological biases influencing our results, our workshop participants did not participate in our evaluation study. Since these participants knew that our project's goal was to generate empathy, they may have exhibited social desirability bias by responding to our questionnaires in a way that facilitated this goal (i.e., by intentionally responding in highly empathetic ways post-session) as opposed to how they truly felt [19]. In addition, they may display confirmation bias while experiencing each VR scenario by discounting VR elements which contradict an initial bias towards only looking for elements that are relevant to empathy generation, particularly since they themselves were involved in the creation of the VR scenes [85]. To that end, their questionnaire responses would skew our results.

We recruited 30 participants (66.7% males) between the ages of 20 and 37 (M_{age} = 25.6, SD = 4.42). Of the 10 Muslim participants, four identified as South Asian, two as White/Caucasian, three as Middle Eastern, and one as Mixed Race (M_{age} = 25.60, SD = 4.70, N_{male} = 6). Of the 10 Christian participants, eight identified as White/Caucasian and two identified as South Asian (M_{age} = 23.1, SD = 1.91, N_{male} = 8). Of the 10 Hindu participants, all identified as South Asian (M_{age} = 28, SD = 4.92, N_{male} = 6).

4.2.2 Experimental Setup. Each participant was assigned to two VR simulations of two faiths different from their own to expose them to at least one faith with which they might be unfamiliar. Muslims engaged with Hinduism and Christian scenarios, Christians with Muslim and Hindu scenarios, and Hindus with Muslim and Christian scenarios. We conducted our study in Toronto, a well-known multicultural city, to isolate the sources of empathic development and interfaith learning by focusing primarily on *Cohabitant*. Our goal was to minimize the influence of personal biases.

Participants completed pre- and post-test IRI, SEE, and IOS questionnaires. In between these questionnaires, they engaged with the *Cohabitant* environment. To familiarize each participant with the VR headset and environment, we initially test ran them in their own faith's VR environment before exposure to the other two faiths. Exposure to the other two faiths was randomized across participants to ensure that the sequence in which the scenarios were presented did not influence participants' responses in a systematic way–so-called *order effects* [167]. Additionally, because we are interested in participants' change in empathy after experiencing different religious experiences *in general*, rather than the differential influence of one religion over another, participants filled out the post-test questionnaires after being immersed in all three VR scenarios. Afterwards, we conducted semi-structured interviews and contextual inquiries to capture participants' reflections, feelings, or feedback. Each participant completed the entire study on the same day over the course of 2 hours. The first part of the study, spanning from the pre-test questionnaire to the post-test questionnaires, accounted for approximately 50% to 60% of the total study duration. The VR immersion for each scene lasted between 5 and 8 minutes, depending on how long participants spent role-playing in the scenes[3]. While participants were told that they were free to pause the study and rest whenever they needed to, formal breaks were not incorporated in the scenes. The participants took a break between 5 and 10 minutes after completing their post-test questionnaire. We spent the remainder of the study time conducting interviews.

5 FINDINGS

In this section, we report the findings of our statistical analyses concerning participants' scores on the IRI, SEE, and IOS questionnaires. We include for each a general analysis of the pre- and post-session scores across all 30 participants, as well as faith-specific analyses which capture more granular trends. We also include a qualitative analysis of insights gained from the semi-structured interviews.

It is important to note that, due to logistical constraints, our results come from a small sample size. Thus, our statistical findings should be viewed as indicative trends. Future work should employ a larger sample for more robust conclusions.

5.1 Results of the User Study

After reverse-coding relevant data and eliminating values related to "decoy" questions used to limit response bias, we conducted paired samples t-tests examining whether interfaith interactions in VR significantly increased participants' empathic concern and perspective taking (IRI), ethnocultural empathy (SEE), and feelings of interpersonal closeness to a member of a different faith (IOS). For all three questionnaires, we predicted that the post-test average would be significantly higher than the pre-test average as a result of immersion in the story-telling and role-playing elements of the VR environments.

5.1.1 Interpersonal Reactivity Index (IRI). Since one participant failed to complete their post-test IRI questionnaire, our final sample for the IRI analysis consisted of 29 participants. Across all participants and faiths (N = 29), a paired samples t-test revealed the

[3]The full scripts of the three VR scenes are included as supplementary materials.

Table 1: Demographics of participants.

Study	Identifier	Self-Identified Religion	Ethnicity	Age	Gender
Design Workshop	PD1	Christianity	White/Caucasian	31	Male
	PD2	Hinduism	South Asian	26	Male
	PD3	Hinduism	South Asian	22	Female
	PD4	Islam	South Asian	24	Male
	PD5	Christianity	White/Caucasian	20	Female
	PD6	Islam	Middle Eastern	30	Female
Pilot Study	PL1	Islam	Middle Eastern	23	Female
	PL2	Christianity	White/Caucasian	NA	Male
	PL3	Islam	South Asian	29	Female
	PL4	Hinduism	South Asian	26	Male
User Study	P1	Islam	Middle Eastern	NA	Female
	P2	Christianity	White/Caucasian	24	Male
	P3	Islam	White/Caucasian	21	Female
	P4	Islam	Middle Eastern	22	Male
	P5	Islam	Middle Eastern	20	Female
	P6	Islam	South Asian	30	Male
	P7	Islam	South Asian	31	Male
	P8	Islam	South Asian	31	Female
	P9	Islam	South Asian	29	Male
	P10	Hinduism	South Asian	31	Male
	P11	Hinduism	South Asian	27	Female
	P12	Hinduism	South Asian	25	Female
	P13	Christianity	South Asian	23	Male
	P14	Hinduism	South Asian	25	Male
	P15	Islam	Mixed Race	21	Male
	P16	Christian	White/Caucasian	22	Male
	P17	Hinduism	South Asian	26	Male
	P18	Islam	White/Caucasian	25	Male
	P19	Hinduism	South Asian	25	Female
	P20	Islam	South Asian	20	Female
	P21	Christianity	South Asian	23	Male
	P22	Christianity	White/Caucasian	21	Male
	P23	Christianity	White/Caucasian	27	Female
	P24	Christianity	White/Caucasian	20	Male
	P25	Christianity	White/Caucasian	24	Male
	P26	Christianity	White/Caucasian	23	Female
	P27	Christianity	White/Caucasian	24	Male
	P28	Hinduism	South Asian	32	Female
	P29	Hinduism	South Asian	32	Male
	P30	Hinduism	South Asian	37	Male

average pre-test IRI score ($M_{pre-test}$ = 3.71, SD = 0.55) to be significantly lower than the average post-test score ($M_{post-test}$ = 3.84, SD = 0.50) (t(28) = 1.740, p < 0.05, Cohen's d = 0.323). Participants therefore showed higher empathic concern and perspective-taking after the VR experience compared to baseline levels measured prior to the session.

We then ran separate paired samples t-tests for each faith group to investigate faith-specific differences in IRI scores. For Muslims, the average pre-test score ($M_{pre-test}$ = 3.53, SD = 0.78) was lower than the average post-test score ($M_{post-test}$ = 3.71, SD = 0.63), but this difference was not significant (t(9) = 1.187, p > 0.05, Cohen's d = 0.375). For Christians, the average pre-test score ($M_{pre-test}$ = 3.87, SD = 0.39) was also lower than average post-test score ($M_{post-test}$ = 3.93, SD = 0.41), but again this difference was not significant (t(8) = 0.783, p > 0.05, Cohen's d = 0.261). The same was true for Hindu participants ($M_{pre-test}$ = 3.75, SD = 0.38) ($M_{post-test}$ = 3.88, SD = 0.46) (t(9) = 1.267, p > 0.05, Cohen's d = 0.401). It is worth noting that this insignificance may be due to the small sample size used for each faith (N = 10 for Muslims; N = 9 for Christians; N = 10 for Hindus). Nonetheless, our findings still show a small to moderate effect on each faith's empathic concern and perspective-taking tendencies (Cohen's d = 0.375; 0.261; 0.400, respectively)[169]. In

psychological research specifically involving human behaviour, the accepted effect sizes typically range from small to medium (Cohen's d = 0.2 - 0.5) [133, 158]. Generally, significant effect sizes in studies using the IRI can also fall within this range [90, 137]. Our findings complement this standard, suggesting that VR immersion may have a meaningful impact on the generation of empathy.

For our data, the Cronbach's alpha for the empathic concern subscale was 0.83, indicating that the measure reliably captures this construct. However, the Cronbach's alpha for perspective taking was lower, at 0.6, indicating questionable reliability. A possible explanation for this may be that a small sample size reduces the likelihood of detecting true consistency in the data. We therefore recommend that future iterations of this study to use larger sample sizes.

Table 2: Summary of findings for IRI, SEE, and IOS across the three faiths.

Measure	Faith	Pre-test *(M)*	Post-test *(M)*	*p*-value	Cohen's *d*
IRI	General	3.71	3.84	< 0.05 *	0.323
	Muslim	3.53	3.71	> 0.05	0.375
	Christian	3.87	3.93	> 0.05	0.261
	Hindu	3.75	3.88	> 0.05	0.41
SEE	General	4.57	4.47	> 0.05	-0.345
	Muslim	4.83	4.73	> 0.05	-0.314
	Christian	4.38	4.17	> 0.05	-0.657
	Hindu	4.58	4.59	> 0.05	0.082
IOS	General	4.90	5.20	= 0.01 *	0.427
	Muslim	6.00	6.20	> 0.05	0.474
	Christian	4.40	4.50	> 0.05	0.114
	Hindu	4.30	4.90	=0.012 *	0.858

5.1.2 Ethnocultural Empathy Scale (SEE). Since five of our participants did not have complete sets of pre- and post-test SEE questionnaires, our final sample for SEE analysis consisted of 25 participants. The Cronbach's alpha for this measure was 0.95, indicating a high level of internal consistency across items. Across all participants and faiths, the average pre-test SEE score ($M_{pre-test}$ = 4.57, SD = 0.74) was not significantly higher than the average post-test score ($M_{post-test}$ = 4.47, SD = 0.92) (t(24) = -1.724, p > 0.05, Cohen's d = -0.345). As indicated by the negative effect size (Cohen's d = -0.345), the VR experience seemed to have the opposite effect by decreasing participants' ethnocultural empathy scores such that post-test scores tended to be lower than pre-test scores.

Faith-specific paired samples t-tests for Muslim participants also indicated no significant increase between pre-test and post-test SEE scores (t(5) = -0.769, p > 0.05, Cohen's d = -0.314). The negative effect size (Cohen's d = -0.314) indicates that the findings are in the opposite direction of what we expected: the average post-test score for Muslims ($M_{post-test}$ = 4.73, SD = 1.18) tended to be lower than the average pre-test score ($M_{pre-test}$ = 4.83, SD = 0.89), not higher. The same was found for Christians, where the average pre-test score ($M_{pre-test}$ = 4.38, SD = 0.82) was higher than the average post-test score ($M_{post-test}$ = 4.17, SD = 1.05), but again not significantly so (t(8) = -1.970, p > 0.05, Cohen's d = -0.657). Here, the large negative effect size (Cohen's d = -0.657) suggests that the VR experience strongly influenced Christian participants' SEE scores in the opposite direction to our predictions[169]. The same general trend was also found for Hindu participants, with the average pre-test score ($M_{pre-test}$ = 4.58, SD = 0.57) being higher than the average post-test score ($M_{post-test}$ = 4.59, SD = 0.57), but not significantly so (t(9) = 0.260, p > 0.05, Cohen's d = 0.082). However, unlike the other two faiths, the VR experience seemed to have a very small effect on Hindu participants' ethnocultural empathy scores (Cohen's d = 0.082). In addition to the general standard of small-to-medium effect sizes reported in studies involving human behavior, past research using the SEE with paired-samples t-tests reported significant effect sizes ranging from from d = 0.2 to d = 0.8 [101]. Our findings are consistent with this.

5.1.3 Inclusion of Other in the Self (IOS). Across all participants and faiths, the average score of interpersonal closeness prior to the VR simulation ($M_{pre-test}$ = 4.90, SD = 1.69) was significantly lower than the average post-test score ($M_{post-test}$ = 5.20, SD = 1.63) (t(29) = 2.340, p = 0.013, Cohen's d = 0.427). Here, the moderate to large effect size (Cohen's d = 0.427) indicates that the VR had a meaningful and noticeable influence on participants' feelings of interfaith closeness.

For Hindu participants specifically, we continued to find a significant increase between pre-test ($M_{pre-test}$ = 4.30, SD = 1.83) and post-test ($M_{post-test}$ = 4.90, SD = 1.60) IOS scores (t(9) = 2.714, p = 0.012, Cohen's d = 0.858), meaning that Hindu participants felt higher interfaith closeness after the VR experience. Additionally, the effect size was large and positive (Cohen's d = 0.848)[169], indicating the VR experience's particularly strong and meaningful influence on feelings of interfaith closeness. We did not find significant increases between pre-test and post-test IOS scores for Muslim participants ($M_{pre-test}$ = 6, SD = 1.05) ($M_{post-test}$ = 6.20, SD = 0.92) (t(9) = 1.50, p > 0.05, Cohen's d = 0.474) or Christian participants ($M_{pre-test}$ = 4.40, SD = 1.65) ($M_{post-test}$ = 4.50, SD = 1.84) (t(9) = 0.361, p > 0.05, Cohen's d = 0.114), though the VR experience still seemed to have a meaningful influence on Muslim participants' IOS scores (Cohen's d = 0.474).

It is worth mentioning that, despite using multiple statistical tests, we did not apply a Bonferroni correction to our p-values. While a Bonferroni correction would decrease the likelihood of obtaining a false positive for each of our tests, our current sample sizes are simply too small to tolerate such a correction. In our case, reducing the significance level from 0.05 to 0.02 (0.05/3 tests) would decrease the chance of a type 1 error at the expense of a type 2 error–i.e., *not* detecting a true signal [8]. To that end, we recommend using our obtained moderate effect sizes as support for the performance of our manipulation, and that future iterations of this research use larger sample sizes. See Table 2 for a summary of these findings.

5.2 Qualitative Findings

Following the psychological measures, we conducted a post-experiment interview and contextual inquiry with each participant.

The interview questions focused on examining the usability of *Cohabitant*, reflecting on the participants' experiences of immersing in various scenes, the psychological challenges of immersion, the ethical questions of any of the role-playing, and the users' overall evaluation of the potential of *Cohabitant* for interfaith connection, learning, and empathy. During contextual inquiries, we recorded participants' comments and asked about specific scenes and their overall user experience with *Cohabitant*, focusing on its usability and effectiveness in achieving its intended purpose. We conducted both the interviews and contextual inquiries in English, transcribed them for analysis, and analyzed the data using an inductive approach [177]. The analysis began with several iterations of reading the interview transcripts and notes from contextual inquiries. Subsequently, we carried out open coding and axial coding, which led to the identification of themes presented in this paper. We report three dominant themes from our qualitative analysis below.

5.2.1 Safer Interactions and Learning via Immersive Experiences. All participants generally valued the immersive experiences provided by the VR scenes, highlighting specific moments that resonated with them. Most expressed appreciation for the opportunity to engage with religion—a subject often considered "private", where many hesitate to inquire about others' beliefs or openly express their own religious identities. Comments such as "at least I can know it from here" and "can I also ask questions to the priests?" (in the Hindu scene), "I never meet Christians; now I understand Easter" (from Muslim participants), and "this reminds me of my own Ramadan and Eid celebrations" (from Muslim participants) indicate that the immersive experience not only facilitates necessary engagement with religious others, but also evokes joy and nostalgia related to one's own faith traditions. Additionally, participants identified specific moments in the VR scenes that held particular significance for them, often influenced by their diverse geographical backgrounds. For example, they expressed interest in adopting the unfamiliar ritualistic and cultural practices they found meaningful.

A notable observation post-immersion was that some participants described their own religious rituals using terms and metaphors from other faiths they had experienced in the VR scenes. Conversely, they interpreted practices from other religions using language and concepts from their own faith traditions. In doing so, many participants recognized the enriching and diverse nature of religious expressions across different cultures and saw them as exemplary practices that could be adopted where appropriate. For instance, P6 reflected on his experiences of Ramadan and Eid:

> I remember, the best thing is when Ramadan ends. On the Eid day, people gathered together in our neighborhood mosque, but not inside of the mosque, the adjacent huge field. And then the Imam recited the duas [prayers] and Quran. Similar to the song and mantra that I have seen in both [Christian and Hindu] VR scenes. You know, it's like Christmas, but a Muslim Christmas.

Sixteen participants explicitly mentioned that having previous experience with VR positively influenced the efficacy of their immersion in the current experiment. Even though we took measures to provide comprehensive training to all participants to ensure their comfort and familiarity with the VR environment before initiating the actual experiment, a subset of participants mentioned that their lack of familiarity with VR limited the effectiveness and meaningfulness of their experience. Experienced participants admitted that their prior experience afforded them a certain level of ease and confidence that enabled them to fully capitalize on the immersive features of *Cohabitant*. For example, P25 said:

> I was interested in interacting with the surrounding objects, which became somewhat distracting. However, this did not interfere with my ability to listen to the storytelling, as I can multitask. Yet, I think this could be distracting for those less familiar with VR, especially since object interaction can be challenging.

To aid novice VR users, participants offered suggestions. Specifically, five participants recommended introducing short "pause" intervals in the VR scenes that won't have any storytelling or role-playing, allowing users time to reflect and prepare for subsequent segments. They also suggested adding intuitive animations they are familiar with to indicate when to engage in specific activities like grabbing or moving objects.

Overall, participants expressed appreciation for immersion experiences as *Cohabitant* allowed them to engage with content embodying faith sentiment, a topic which they described as "uncomfortable," "private," and "sensitive" in the public spheres. In addition to their positive feedback, participants also offered constructive suggestions aimed at enhancing the educational value of the VR scenes and facilitating more effective empathy-building in future iterations.

5.2.2 Faith Sensitivity and Ethics of Contact. While participants generally valued the immersive experience, our study surfaced a spectrum of ethical concerns and varying degrees of sensitivity during specific moments in the VR scenes. These concerns ranged from the accuracy of religious representations to the handling of cultural and ritualistic sensitivity and diversity within a single faith, as well as ethical tensions in the active versus passive immersion within the role-playing scenarios. Additionally, participants voiced fears about exposure to scenes that might conflict with their own religious beliefs.

Six participants either disengaged from certain scenes or requested that we skip them due to perceived conflicts with their religious ethics. For instance, a Christian participant paused during a Hindu temple scene when asked to offer "prasad" to a deity. He cited that this action conflicted with his monotheistic beliefs as he mentioned that offering deity would mean that he is supporting, in his words, "polytheistic systems of belief". Similarly, a Muslim participant expressed reservations about a Christian scene involving the offering of wine, as alcohol consumption is prohibited in Islam. Participants were not only conscious of their own beliefs and theological considerations while engaging with the VR scenes, but they also expressed concerns about the broader social implications of these virtual experiences. P22 elaborated on these ranges of sensitivity:

> In the Islam thing. I'm just watching them [people praying]. I'm not taking part. I'm not actually like, you know, doing the prayers. But in the Hinduism scene, like, I believe that I am paying tribute or paying heed to that call, Durga, which is like, it's, it's against

> my religion. It's kind of, in a way, worshipping that God.

In contrast to the above, the majority of the participants reported a level of comfort with the immersive scenes and associated role-playing activities. At the initiation of the study, we explicitly informed participants that they could discontinue their involvement should they encounter ethical or emotional discomfort during any segment of the experiment. Subsequent follow-up inquiries revealed minimal instances of ethical or emotional conflict for the participants. Three respondents articulated that navigating ethical conflicts is a requisite skill in an increasingly pluralistic society and they find creative ways to resolve them, while also conforming to their religious learning. Additionally, five participants noted the inevitability of interfaith interactions in their social circles and expressed uncertainty regarding the ethical boundaries of their discussions. They proposed that virtual reality could serve as a useful medium for spotlighting these tensions and providing training in effective interfaith dialogue and conflict resolution. P24 elaborated as follows:

> I think that this sort of experience is helping me in continuing my process of appreciating that humans are going to create this sort of thing. And then it's up to us to try to keep it from becoming oppressive [using religion]. And, I appreciate the fact that conflict is part of life. And how do we deal with it? Well, if we have these practices that help us renew into the new life, then we're helping one another deal with the fact that yeah, life is pretty crappy lots of times. How do we get through it? Supporting one another.

Eight participants suggested that VR technology could further offer creative opportunities to address some ethical tensions associated with interfaith contact. For example, some Muslim participants noted that taking non-Muslim friends to a mosque might not be culturally sensitive, but that the virtual experience provided a viable alternative. Hindu participants expressed similar sentiments concerning ritual activities. Through these reflections, participants highlighted the potential of VR to overcome various ethical and cultural tensions by enabling alternative modes of contact.

5.2.3 Connection, Learning, and Empathy. In addition to mitigating ethical concerns related to contact, our participants also highlighted the valuable role of VR in addressing social anxieties, resource limitations, and the gaps in traditional, practical religious training to foster interfaith learning and build empathic connection. They noted that religious discussions are often set apart from everyday conversations in public, which can create tension and discomfort when these topics naturally come up in daily life. They also commented on how religious institutions often avoid teaching people how to respectfully interact with followers of other religions, overtly focusing instead on ritualistic practices. To fill this gap, participants suggested that VR could be used to supplement traditional religious education, particularly in teaching people how to interact respectfully with those from other faiths. P13 mentioned:

> But I've many times, in my efforts to try to belong to a church, attended church and ended up asking to spend time with the pastors, and ask all kinds of questions. And lots of times they agree with me, but they still won't necessarily try to change how the church operates, because they're hired for helping the people practice what they are used to practicing. There are few who do it differently, but not as many as I would like to see.

Eight participants discussed instances within the VR scenarios that served to reaffirm and extend their understanding of religious ethics and other related topics. Some participants had previously observed or even partaken in rituals of other religions but were unaware of their underlying significance. Immersion in the VR scenes facilitated their comprehension of the stories and meanings behind these rituals, allowing them to make meaningful connections. P20 expressed appreciation for the 'first-hand' experiential learning that the VR environment provided,

> In Christianity, I have no idea what Easter was, I was just gonna, you know, have a family dinner. That's like a thing that they do. But then I learned like, oh, there's a reason that they do that. You make assumptions on various things you see. But when you talk to them, and when you get to know people from other religions, you find out they're like, a lot of intricacies and different issues. The VR scenes were like this. I got to know more of what I saw before.

Eleven participants indicated that their exposure to the VR scenarios led to greater familiarity with novel cultural expressions of rituals, ethnic practices, and other facets of religious observance. This experience also provoked a deeper curiosity to further explore these elements. For instance, one Christian participant noted that while she had previously observed her Muslim friend's dedication to Ramadan and the subsequent celebration of Eid, her engagement with the VR environment heightened her curiosity about the religious importance of this month. Similarly, other participants expressed interest in understanding the religious significance behind dietary practices, colors, rituals, family celebrations, and communal activities. P18 shared this sentiment:

> I have seen movies where the mosque is portrayed. So I knew what happened in Islam a little bit. I know Christianity as well. But, I've never been to an Easter festival. I've been to church with friends during some events. And so I do have a little bit of idea for all the three religions to a certain extent. But, after today's experience, I think they are much more interesting than I thought. I might ask more questions to my friends from now on.

Ten participants identified specific moments in the VR simulations that resonated with their own values, describing these instances as "value confluences". Participants elaborated on these moments in a manner that suggested these singular experiences served as catalysts for deeper learning about the cultures and peoples represented by the various religions. These specific moments stood apart from general similarities observed across all VR scenes, such as the wearing of clean clothing or the sharing of communal meals. It's worth noting that these moments of value confluence were often not explicitly pointed out in our instructional script; instead, they arose from and resonated with the participants' own

interpretations and personal memories. For example, one Christian participant noticed that the Hindu ritual meal 'vogh' consisted of several vegetarian dishes. This observation resonated with their own vegetarian lifestyle, leading them to appreciate the significance a major religion places on vegetarian diets through its rituals.

Nevertheless, participants identified critical challenges associated with the use of virtual reality (VR) for interfaith contact and learning. Two predominant issues were the inherent limitations of VR in accurately replicating human interactions and the difficulties in translating learning into tangible shifts in attitudes and levels of empathy. Concurrently, participants identified both contextual and technological resources that could be employed to mitigate some of these inherent limitations.

Seven participants indicated that their multicultural upbringing or exposure rendered them better equipped to engage with the VR-based learning experiences. This exposure to cultural diversity, encapsulating various religious practices, made them more open and receptive to reflections on their own faith and the faiths of others. Their flexibility and willingness to learn were evidenced by the depth of their engagement with the VR scenes. For instance, P22 remarked:

> Like I was born in the Middle East. I was born in Dubai. So like, we used to, you know, make the prayer in class. I had a lot of Muslim friends and a lot of Hindu friends as well. So yeah, I know how it works for them. But I have more opportunities to learn about my friends, why not!

Some participants highlighted how isolated moments of positive engagement influenced their overall learning experience, creating a favorable impression of the virtual reality scenes. Some participants made connections, albeit passively, through the VR scenes of artistic expressions. They spoke about the emotional impact of religious hymns in Christianity, Quranic recitations in Islam, and mantras in Hinduism. These affective elements, often rooted in artistic expression, elicited 'feel-good' moments and fostered a positive impression of other religious groups. P17 stated:

> If other people treat you good and make you feel good about something, even though you might not be able to fully comprehend it or understand it, you feel better. The Quran was Arabic. And you don't really, you aren't able to comprehend or understand it, but just hearing the tones and the notes and the pitch and just seeing people come together, makes it special, so I definitely felt comfortable. And I like the idea of sharing food afterwards, it was pretty good.

Regarding the comprehensiveness of the VR experiences, five participants pointed out that the scenes lacked communal aspects of religious celebrations. They made this observation based on their own religious experiences in their culture. Participants suggested that the communal aspects of religious celebrations could serve as an avenue for connecting individuals from different faiths. P15 noted:

> There are more actions going on in my community other than what I have seen. People are hugging, hanging out, and whatnot. That aspect was missing. I saw what was done by a single person. But yeah, there could be a more communal aspect of this.

In summary, our study reveals that VR can offer promising avenues for interfaith learning and empathy-building, filling gaps often left by traditional religious training. Participants found value in the experiential learning and 'value confluences' that VR facilitated. However, challenges remain, including VR's limitations in replicating human interaction and its effectiveness in influencing long-term attitudes. Overall, while not a complete solution, VR presents a valuable supplemental resource for fostering interfaith understanding.

6 VR FOR INTERFAITH EMPATHY AND LEARNING: IMPLICATIONS FOR DESIGN AND PRACTICE

6.1 Discussion of the Findings from Statistical Analysis

Overall, our findings suggest that, under certain circumstances, *Cohabitant* increases users' tendencies to show empathy and to feel close to others. However, the application appears to decrease participants' ethnocultural empathy. We discuss possible theoretical mechanisms for these findings, and how our design may have contributed to these results.

Similar to our set-up, past work that employs "day-in-the-life" simulations has shown that VR perspective-taking and sensory immersion enhance cognitive empathy [12, 182]. Evidence also suggests that immersive VR raises levels of spatial presence (a sense of being in VR) and social presence (a subjective connectedness with a person in VR) [35, 104], both linked to greater affective and cognitive empathy [95]. *Cohabitant*, featuring multi-directional movement, object manipulation, and character interaction, likely contributed to a heightened spatial and social presence that increased post-session empathy.

We know that emotional expression can serve as a social signal that affects listener-speaker emotional synchrony [62, 181], and that sharing both happy and complex emotional stories fosters interpersonal closeness [11, 102, 195]. Further, people also inherently seek to broaden their self-competence and resources through the inclusion of a partner's attributes [10]. In the case of *Cohabitant*, participants were immersed in a VR experience of joyful and major religious festivals. They listened to narrators recount fond childhood memories and express positive and negative feelings. In providing this experience, *Cohabitant* may have enriched participants' self-competence and interpersonal perspectives in a way that increased feelings of closeness.

In contrast, the decreased ethnocultural empathy scores may be attributed to the phenomenon often referred to as "out-group hate," which increases both when the in-group is made salient as well as when the in-group norm tends to be discriminatory [77]. Assuming that lower ethnocultural empathy scores can be interpreted as an instance of "out-group hate", it is possible that the initial experience of the simulation of their *own* faith unintentionally emphasized participants' in-group identity and resulted in subsequent interactions with *other* faiths feeling more like "out-group" experiences. Another possibility is that participants may have simply realized

the true extent of their limited understanding of other faiths after experiencing *Cohabitant*, and the lower ethnocultural empathy scores reflected an over-correction. For example, one question in the SEE asks participants is how much they believe statements such as "*It is easy for me to understand what it would feel like to be a person of another racial or ethnic background other than my own*". *Cohabitant* may have led participants to realize that they perhaps did not understand the lived experiences of others as much as they had assumed they did.

While we were interested in understanding general changes in empathy after exposure to multiple, different faiths *in general*, there may also be faith-specific implicit biases influencing these results. This could be an interesting avenue for future research.

6.2 Religion in the Public Spheres: Addressing Tensions and Creating an Alternative Site for Connections

Our study contributes by highlighting the capacity of *Cohabitant* (as well as similar interactive technologies) in addressing long-standing tensions relating to coexistence of religious groups in public spaces. Historically, the Enlightenment and its ally, secularism, have relegated religion to the private sphere, undermining its roles in public politics and everyday ethics [59, 93]. Centuries of secularism practices have painted individuals as "modern" based on their inclination to withhold religious values and sensitivities in public spheres and their everyday practices of ethics [22, 73, 105]. This trend is evident among our participants. Most participants felt uneasy discussing faith in public, deeming it inappropriate and insensitive, but still recognized religion's importance in a multicultural society. Despite our probing, none reported past negative experiences that could explain this discomfort. However, these participants were still comfortable discussing religion in private settings, like family gatherings or with friends. These findings echo existing critiques of secularism [21, 116, 117], which suggest implicit societal conditioning discourages public religious connections and discourse.

Collectively, these findings and the existing literature unveil a noticeable tension. On the one hand, interfaith engagement and mutual learning have been recognized as important mechanisms for reducing faith-based polarization in society. On the other hand, there is a resistance to such engagement due to the social and cultural environment cultivated through secular and modern values. In this context, as our findings have shown, *Cohabitant* offers an alternative space to create opportunities for contact and learning experiences.

6.3 Group vs. Individual Empathy: Design Nuances

Our study revealed design nuances that can affect individual versus group connections in the context of interfaith relationships. Our evidence indicated that *Cohabitant* significantly increased interpersonal empathy but fell short in generating ethnocultural empathy. These results invite multiple interpretations and highlight the need for additional research in varied settings to explore the associated design considerations. One interpretation relates to secondary contact theory [127, 175, 185], a subtheory of Allport's contact theory. This theory posits that indirect "contact," such as hearing stories, observing interactions, or media representations, can increase intergroup learning and empathy. Given that our participants have lived experiences in multi-cultural and multi-ethnic societies, they likely have experienced secondary contact in various settings, either privately or publicly. The effectiveness of *Cohabitant* in improving interpersonal empathy may partly be due to these pre-existing secondary contact experiences.

On the other hand, when interested in learning, participants said they learned about religions as ethnocultural groups mainly from external sources like media and the Internet. Media studies literature suggests that digital media and political campaigns strongly influence perceptions about religious groups, often promoting stereotypes [109, 149, 168]. The rise of social media and the pursuit of "virality" [142] have amplified inaccurate portrayals of religious groups. Additionally, short exposure to *Cohabitant* might have led participants to revisit their own biases, possibly concluding that their previously held notions about various faiths were inaccurate. As a result, their self-reported scores on the SEE regarding their ability to empathize with those from other ethnicities decreased to reflect this personal belief correction. Besides the interpretations mentioned, other factors and viewpoints should be considered in future design works, particularly focusing on the context of social and historical settings.

For the next iteration of our study, we plan to focus on individual versus group dynamics. This focus will inform both script development and role-playing scenarios while also allowing us to explore additional design resources. Existing HCI literature [61, 144] provides useful guidelines for customizing design to either individual or group settings.

6.4 Ethical Considerations: Adapting Ethically Inappropriate Contacts and Actions

Our study contributes to an emergent body of literature at the intersection of ethics, engagement, and design. Our findings clarify how religious orientations distinctly affect users' willingness to engage in a virtual reality environment like *Cohabitant*. One set of findings suggests that many participants do not find ethical dilemmas in engaging with religious "others". They even view the virtual experience as an extension of their religious teachings to foster understanding about other religious groups and challenge prejudices about them. However, a subset of participants expressed reservations or outright rejections toward certain role-playing elements in the VR scenes. These findings suggest that some "contact" in the interfaith context may be inappropriate, and even considered as a "breach". For example, immersing in "ritual" scenes for some participants in our case raised ethical conflict. Iterative evaluations and design approaches with sufficient control for users in the VR scenes may address these ethical dilemmas. Moreover, care must be taken to identify potential ethical conflicts in interactive tools like ours. For instance, assuring our participants that they could choose to eliminate or bypass the ritual scenes in *Cohabitant* increased their confidence that they would not be immersed in anything their religion might prohibit. Such control for bypassing certain moments in the scenes didn't hinder our goal of fostering interfaith connections.

The future versions of *Cohabitant* could adopt a "tiered engagement" strategy. Users could choose their level of immersion based on their comfort and ethical guidelines, ranging from "full immersion" to a "passive observer" mode, while still maintaining a similar degree of connection and learning opportunities [78, 153]. Developers could also create an "adaptive storytelling" feature, letting users customize narrative elements to match their ethical or religious sensitivities [23, 42, 51].

6.5 Challenges, Limitations, and Future Work

Our user study suggests that the lack of "reflection" time between actions and narrations may have impacted the study's statistical outcomes. This aligns with research indicating that perceived partner responsiveness enhances interpersonal closeness [131]. To address this limitation, future designs could include "unrelated-to-empathy" elements (also suggested by [91]) or intentional pauses to allow participants time for reflection. Alternatively, the progression of VR scenes could be made dependent on participants' actions and/or prompts to allow for individual reflection time.

Additionally, another area of improvement relates to research suggesting that explicitly verbalizing similarities with a disclosed fact or emotion can increase feelings of closeness [102]. For instance, rather than the narrator simply stating, "We must take a bath before going to the *mandap* (temple), because it is a pure and holy place that requires us to be clean," we could add, "I know that as a Muslim, you also have to take a bath before Eid prayers, emphasizing the importance of cleanliness in Islam." This approach not only validates the participant but also highlights genuine similarities between different faith groups.

We mention a few notes of clarification about the use of term "empathy" and its impact here. We approach the concept of "empathy" following a wide body of empathy research in psychology, as explained above, in which empathy is often indirectly measured through various subscales. For example, the IRI is the field-standard measure of empathy, yet it specifically measures perspective taking, empathic concern, personal distress, and fantasy in order to arrive at a measure of cognitive empathy and affective empathy [38]. In this way, the literature does not utilize a specific measure of "general empathy." Rather, the term empathy is used as a proxy for the aggregate of its internal subscales. Thus, to remain consistent with the conventions of the field, this is also the approach we took.

It is important to note that in HCI research, several studies have captured and applied the concept of empathy, particularly where design of user experiences is concerned. However, to our knowledge, these studies do not directly measure empathy using any validated scales. For example, in a study examining empathy's effect on user satisfaction in the context of human-computer dialogue, empathy was informally operationalized as the frequency with which the system agreed or disagreed with users' statements in a conversation [70]. Additionally, measuring general approaches vs. empathic approaches to the study of user experience seems to be two distinct categories in HCI, where the former is concerned with aspects of the user's experience that can be directly measured and improved and the latter with drawing from more qualitative experiences such as emotional encounters, people's dreams, and life contexts [193]. Our study uses validated and widely-used empathy scales from psychology to combine both these approaches into one, enabling us to more concretely measure this construct.

Finally, by virtue of our study design, our findings are primarily relevant to short-term changes in empathy. Future work can employ longitudinal study designs to assess the evolution of empathy as a result of interfaith contact over longer periods of time.

In future versions of *Cohabitant*, we plan to include non-religious groups and various subgroups within the same religions. For example, religious commitment in already-religious people has evidenced positive correlations to prosocial behaviours [56, 159]. For non-religious people, however, the conduit for prosociality appears to be compassion [152]. This suggests that our participants' levels of religious commitment—a variable we did not measure—may be playing a part. We recommend that future researchers record this variance, particularly because examining empathy in VR while accounting for these nuances may offer insight into the possible underlying mechanism of its generation.This approach will necessitate tailored design and ethical approaches, and a major challenge lies in finding common ground among groups with varied ethical backgrounds to promote shared learning experiences. We encourage future researchers interested in this topic to carefully consider this when planning their approach [139].

7 CONCLUSION

We have contributed to the field of HCI by designing, implementing, and evaluating *Cohabitant*: a VR application aimed at fostering interfaith connections, learning, and empathy. Our design was informed by an extensive body of literature at the intersection of intergroup contact, HCI, and psychology. We also conducted a participatory design workshop involving participants from three religious backgrounds: Christianity, Hinduism, and Islam. *Cohabitant* offers an immersive experience that guides participants through a typical day of celebration in a religion different from their own, with the aim of enhancing interfaith understanding and empathy. Our user study, which combined empathy measurements and qualitative reflection, showed that *Cohabitant* succeeded in improving interpersonal empathy but fell short at the ethnocultural level. These mixed results underscore the potential of using VR and similar interactive technologies for interfaith contact, while also raising important ethical, design, and group dynamics questions, including the role of religion in public spheres. Addressing these complex issues within HCI will require multidisciplinary approaches that take into account religious sensitivities and the plurality of practices across diverse settings.

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