

LegacySphere: Facilitating Intergenerational Communication Through Perspective-Taking and Storytelling in Embodied VR

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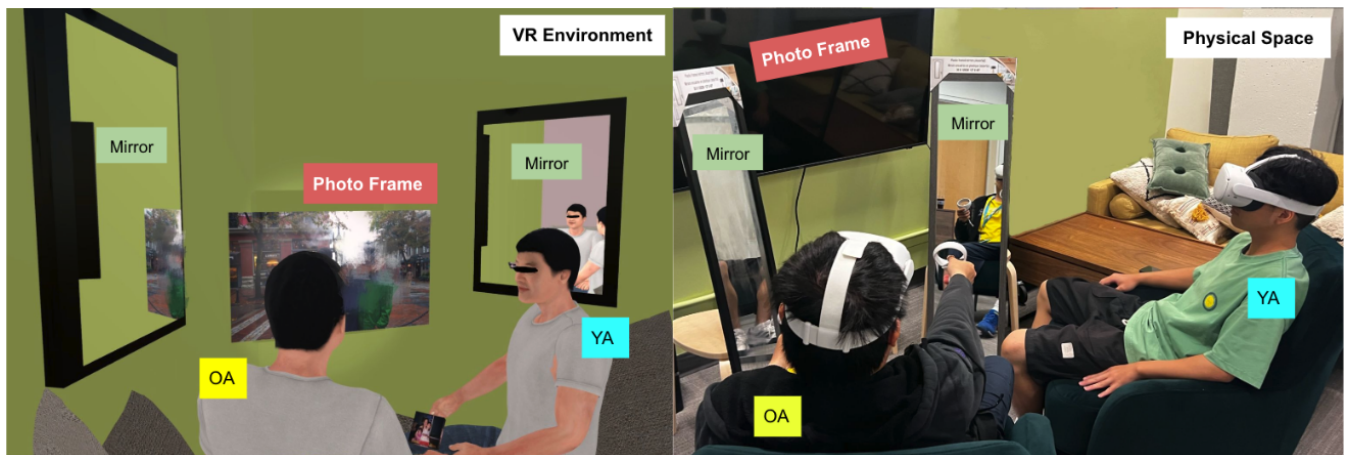


Figure 1: Overview of LegacySphere in one of the scenarios. The VR environment (left half of figure) is mapped to the physical space (right half). The older adult (left) and the younger adult (right) both embody the older adult’s current avatar in this scenario and are seated next to each other.

ABSTRACT

Intergenerational communication can enhance well-being and family cohesion, but stereotypes and low empathy can be barriers to achieving effective communication. VR perspective-taking is a potential approach that is known to enhance understanding and empathy toward others by allowing a user to take another’s viewpoint. In this study, we introduce LegacySphere, a novel VR perspective-taking experience leveraging the combination of embodiment, role-play, and storytelling. To explore LegacySphere’s design and impact, we conducted an observational study involving five dyads with a one-generation gap. We found that LegacySphere promotes empathetic and reflexive intergenerational dialogue. Specifically, avatar embodiment encourages what we term “relationship cushioning,” fostering a trustful, open environment for genuine communications. The blending of real and embodied identities prompts insightful questions, merging both perspectives. The experience also nurtures a sense of unity and stimulates reflections on aging. Our work

highlights the potential of immersive technologies for enhancing empathetic intergenerational relationships.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design; Interactive systems and tools; Virtual reality.**

KEYWORDS

Virtual Reality, Intergenerational communication, Perspective-taking, Empathy, Role-play, Storytelling, Proteus effect

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1 INTRODUCTION

Intergenerational communication (IGC) is the exchange of information, ideas, beliefs, and feelings between people of different generations [77]. IGC plays a crucial role in building relationships, preserving family heritage, and fostering understanding and mutual respect among different generations [7, 22]. However, emotional and relationship barriers often hinder effective IGC. Young adults,

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for instance, may feel defensive due to cultural norms and expectations of deference [23, 82]. Negative age stereotypes [3], disapproval [22], and a lack of empathy [82] towards the younger generation by the elder can also contribute to these barriers. As a result, failed IGC can lead to dissatisfaction and, at times, conflict instead of achieving its intended goal.

Human-Computer Interaction (HCI) studies on IGC have primarily focused on making IGC more accessible and easier. Some have delved into bridging distances, enabling grandparents and grandchildren to communicate across miles [43, 76]. Others have investigated interactive mementos, creating artifacts like digital archives and tangibles that evoke memories and foster conversations [8, 38, 41, 42, 73]. However, addressing the abovementioned emotional and relationship barriers in IGC remains a significant challenge. Our work aims to enhance IGC quality by promoting empathy and understanding.

In the domain of Virtual Reality (VR) research, the *perspective-taking* approach shows potential for enhancing empathy and understanding of others [27, 72]. VR perspective-taking allows users to experience situations from another person’s viewpoint—by embodying that person’s avatar—thereby giving them a first-hand understanding of the other’s experiences. This immersive “walk in someone else’s shoes” experience has been shown to reduce negative stereotypes [79] and bias [26] towards others, particularly those identified as out-group. The theoretical underpinning of this experience is the Proteus Effect, a phenomenon where a person’s behavior and perspective change based on their digital self-representation (i.e., avatar) in VR [80]. This theory suggests the potential for employing perspective-taking to enhance IGC. A heightened sense of empathy could enable different generations to appreciate varying perspectives, build trust, reduce misunderstandings, and foster respect and acceptance [57, 78].

Our research aims to explore the design of a VR perspective-taking experience to enhance empathy and understanding in IGC and investigate its potential effects. The design of LegacySpace focuses on promoting empathy and understanding dialogue between younger adults (YAs) and older adults (OAs), specifically by enhancing the YA’s empathy towards the OA. The design amalgamates three core elements: (1) Avatar embodiment, where the YA embodies the avatar of the OA to help them understand and empathize with the OA’s past experiences and emotions as depicted in Figure 1, (2) a storytelling procedure that encourages the OA to share their narratives with the YA, and (3) a role-playing protocol structured to encourage the YA to assume the role of the OA, prompting them to reflect on the narratives shared by the OA and ask questions. Furthermore, our avatar embodiment design allows for the avatar representation of the OA to be varied, such as a younger version of the OA. Overall, the design of LegacySpace employs the avatar as the medium for IGC allowing the creation of a shared narrative space where history meets the present to foster empathetic dialogues.

To gauge the effect of LegacySpace and how its design elements shape IGC, we conducted an exploratory observational study. The study involved ten participants (five parent-child dyads with a one-generation gap) using LegacySpace. To facilitate exploration of different perspective-taking scenarios, we diversified two key design dimensions of avatars and roles taken by the YA—identity (YA’s

self and OA) and time (young OA and current OA). After the participants experienced all scenarios, we conducted semi-structured interviews and analyzed the data using thematic analysis. We found that LegacySphere fosters empathetic and reflexive intergenerational dialogue. Specifically, avatar embodiment encourages “relationship cushioning,” fostering a trustful and open environment for genuine conversation. The blending of real and embodied identities prompts insightful questions, merging both perspectives. The experience also nurtures a sense of unity and stimulates reflections on aging.

Our work contributes to the existing body of knowledge in two significant ways:

- (Design/System) We present LegacySpace, a novel VR experience that employs perspective-taking to facilitate rich IGC and enhance understanding and empathy towards the life experiences of other family members.
- (Empirical) We offer detailed insight into the impact of our design elements—namely, avatar embodiment setups, storytelling procedures, and role-playing activities—on both OAs and YAs. Our findings encompass individual reactions and the evolving dynamics in their interactions, suggesting improvements in empathy, communication styles, and mutual understanding.

Our study underscores the transformative potential of VR in IGC and lays the foundation for future exploration and application of immersive technology in this vital area.

2 RELATED WORK

2.1 Storytelling for Intergenerational Communication

Storytelling is a powerful tool for IGC, promoting shared experiences, active listening, cultural preservation, creativity, imagination, and opportunities for learning. As a medium for the social transmission of lived wisdom, storytelling transfers cultural values, knowledge, and practices to the next generation [40, 43–46]. As elders share personal memories with the younger generation, both parties may benefit from the emotional connection forged and the accompanying sense of well-being [54]. Researchers have also found that storytelling can increase empathetic response in the audience by putting them in another’s shoes and allowing them to experience being another person [48].

Numerous storytelling systems designed for IGC already exist, demonstrating the effectiveness of storytelling as a method. Li et. al. crafted an inventive system known as Story-Me. It features a slot-machine-like device designed for OAs, paired with a corresponding mobile application tailored for their children. The primary objective of Story-Me is to foster intergenerational story-sharing, specifically focusing on life stories and family mementos [43]. Kang et. al. developed MomentMeld, an AI-powered mobile application that generates context-specific collections of photos that highlight shared life milestones across generations, referred to as “mutually stimulatory mementos,” thus emphasizing the similarities between different age groups [33]. Storytelling has long served as a powerful means to convey heritage experiences, enrich generativity, and shape individual and collective identities. Within

the African American community, traditions are passed down to younger generations through oral storytelling, which strengthens familial bonds and reinforces connections within African American families [18].

LegacySphere utilizes the concept of VR perspective-taking to enhance intergenerational storytelling. Its primary goal is to not only deepen the younger generation's comprehension of the older generation's past experiences conveyed as stories but also to provide a platform for YAs to empathize with OAs and create a foundation for meaningful discussions.

2.2 VR Perspective-Taking: How Avatar Embodiment and Proteus Effect Impacts Empathy

Perspective-taking, the capacity to intellectually comprehend and take into account another person's viewpoint and thoughts, is recognized as a method for cultivating empathy towards others [59, 60, 72]. Compared to non-immersive perspective-taking techniques, VR perspective-taking can have a stronger impact on individuals [80]. VR perspective-taking allows users to obtain experiences which could be difficult or impossible in reality, such as having a different gender [67], age [51] or race [25]. VR perspective-taking has been used in promoting empathy toward other people [62]. There are two types of empathy. Cognitive empathy is the ability to understand and think about how someone else is feeling. It's more of an intellectual understanding of someone else's emotions, rather than directly sharing those emotions [64]. Emotional empathy, also known as affective empathy, involves directly feeling the emotions that another person is experiencing. This type of empathy engages several areas of the brain, with the most prominent one being the mirror neuron system [16]. Perspective-taking is a great method to achieve cognitive empathy [59, 60, 72].

The Proteus Effect is a psychological phenomenon in which the behavior and attitudes of an individual are influenced by their virtual self-representation, such as an avatar, in a virtual environment [78]. It is rooted in three psychological concepts: behavioral confirmation [68], self-perception theory [5], and deindividuation [56]. The theory, first introduced by Yee et al. in 2007 [78], proposes that the identity cues present in a user's avatar can lead to behavioral and attitudinal changes and promote empathy toward that identity. The Proteus Effect occurs when individuals act in accordance with the appearance of their avatars, both within and beyond the virtual environment. Prior studies have demonstrated the effectiveness of VR in fostering the Proteus Effect [57]. In one particular investigation, VR was utilized to create the illusion among participants that they inhabited a body of a different race [26]. Prior studies have indicated that when Caucasian individuals experience a brief period of embodiment in Black virtual bodies, it leads to a reduction in their racial bias against Black people [53]. Users in more attractive avatars are friendlier and more extroverted toward other people [78].

Research on the Proteus Effect has been conducted under different scenarios, such as financial risk-taking [28], consumer choices [2], dating partner choices [80], student engagement [58], and negotiation aggressiveness [78]. However, it remains unclear how

leveraging the Proteus Effect through VR can benefit intergenerational communication (IGC). Our project aims to fill this gap by investigating the effectiveness of the Proteus Effect in strengthening the emotional connection between family members.

2.3 Leveraging Role-play in Psychology and HCI

Role-play methods have been recognized as effective in enhancing users' psychological embodiment of their assigned identities while promoting empathy among individuals, as they allow for the experience of different perspectives and understanding of others' viewpoints [37]. There are three types of role-play commonly utilized: emotional role-playing [31, 47], counterattitudinal role-playing [17], and empathic role-playing [13].

In our study, we incorporate empathic role-playing in conjunction with the use of the Proteus Effect to enhance participants' engagement and responsiveness to their avatar's identity. Empathic role-playing seeks to foster increased empathy towards a specific group by allowing individuals to "walk in their shoes". This approach has become widely adopted in training programs, especially in educating preservice health professional students in empathy. In these scenarios, learners take on the role of the patient to gain a deeper understanding. [4, 36, 55]. Empathy role-playing is employed to address intercultural communication barriers. For instance, students devise scenarios depicting such barriers in professional contexts, subsequently engaging in role-play to showcase solutions. This approach cultivates enhanced communication skills and a richer comprehension of intercultural communication intricacy. [39]. It also has the potential to impact how individuals understand local issues and engage with their communities [24]. The development of VR technologies has introduced new possibilities for role-playing. Instead of merely imagining the mindset of another person, individuals can more directly assume the perspective of another person through the use of avatars [52].

However, the impact of role-play on IGC remains underexplored. We aim to address this gap by investigating how role-play can influence and potentially improve IGC dynamics. By exploring the effects of role-play within the context of different generations interacting, we hope to gain insights into its potential benefits for fostering better communication and understanding among family members.

3 DESIGNING LEGACYSPIHERE

In this section, we present the design of LegacySphere. Our design approach was primarily focused on fostering empathy in YAs towards OAs, as the key issue in IGC is often the negative perception and attitude of YAs towards OAs [3, 23, 82]. As a result, in our design, only the YAs experiences perspective-taking, while the OAs are embodied in their own avatar. Yet, we anticipate that the impact of the perspective-taking approach will be felt by both, as communication is inherently a reciprocal process. Our system is designed to support one-on-one conversations between a YA and an OA.

Based on previous studies and iterative design, we established that a coherent *scenario* is essential for successfully evoking empathy in perspective-taking experiences [2, 27, 28]. In this context,

by “scenario”, we mean a structured scene crafted to make the perspective-taking experience convincing, coherent, and believable.

3.1 Two Dimensions of Perspective-Taking Scenarios: Identity and Age

We identified two key dimensions for creating scenarios that enhance IGC: the identity and age of the other character whose perspective the YA user takes on.

3.1.1 Identity. The identity of the individual whose perspective is taken by the user significantly impacts their self-perception during social interactions with other users [57], a phenomenon central to the Proteus Effect [80]. We found that taking the perspective of the OA would be the most effective option to evoke empathy and understanding in the YA towards the OA’s past experiences.

3.1.2 Age. Age is an important element related to the IGC context. Prior studies have demonstrated that taking the perspective of an older person in VR can significantly reduce age-related stereotypes in young individuals [79]. Such findings have inspired us to consider age as a dimension in our scenario design. This means that when the YA takes the perspective of the OA, the scenario can present the OA in either their current age, or as their younger self.

3.1.3 Two Representative Scenarios and Untapped Opportunities. After exploring numerous potential scenarios, we identified two that are particularly relevant to enhancing YA’s empathy towards OA. In both scenarios, the OA is represented as they are, not taking the perspective of another person.

- **OA’s Inner Monologue:** Here, the YA embodies the perspective of the OA at present. This scenario helps counter assumptions or stereotypes the YA might hold about the OA’s daily life, fostering a deeper understanding of the OA’s worldview, and potentially creating a more compassionate and tolerant communication.
- **Past Meets Future:** This scenario places the YA in the shoes of the OA during their youth, offering a glimpse into the socio-cultural and personal challenges faced by the OA. By examining the OA’s younger days. The YA may be able to relate to universal human emotions and dilemmas that persist across generations. This historical perspective can challenge the YA’s biases about the OA’s life decisions and the world they grew up in, emphasizing more commonalities than differences.

These two scenarios represent only two of a larger set of possible scenarios that span our two design dimensions, where the identity the YA assumes could be the YA themselves, the OA, or a third person, and age could be at any point in the human lifespan. An additional consideration could be to also provide the OA with a perspective-taking experience, which could lead to an exponential expansion of possible scenarios. However, exploring all these scenarios is beyond the scope of this study and is left for future work.

3.2 Design Elements of Scenarios

In LegacySphere, a perspective-taking scenario is realized through a combination of three core design elements: avatar embodiment, storytelling process, and role-playing protocol.

3.2.1 Avatar Embodiment. The avatar embodiment setup was carefully designed to enhance participants’ connection to the identities assigned to them in the given scenario, and to facilitate IGC in the dyad. Both users are embodied in the shared VR space, as mutual embodiment is critical for facilitating communication [1].

The primary consideration is the avatar modeling. For the YA, we aligned the perceived identity of the avatar with the assumptions of the given scenario. Unlike the YA, the OA is not subject to perspective-taking, and therefore they are represented by an avatar mirroring their current appearance. Figure 2 presents a set of avatars generated from photos of one of our participant dyads. Another key component of avatar embodiment is our immersion facilitation protocol, distilled from methodologies in previous research. Prior to being immersed into a scenario, participants are instructed to look into the mirror and observe their avatars, which represent their new identities, allowing them to acclimate to their new persona. Subsequently, to establish their new identity in the IGC context, they are guided to initiate a dialogue with each other, assuming their new roles. An example instruction for the “Past Meets Future” scenario goes as follows:

Now, [YA] will become [OA] in their younger age. As [OA], you will encounter important events that are about to happen to your future self. Look at yourself in the mirror and try to imagine yourself as the younger [OA]. Try saying a few words as [OA] in their young age to the future [OA], using the first person narrative. For [OA], the person sitting next to you right now is your younger self. Turn to them and say a few words to your younger self.

3.2.2 Storytelling Procedure. Following the immersion facilitation protocol, the next activity in the LegacySphere experience is the OA’s *storytelling*. The role of storytelling in facilitating the transfer of cultural values, knowledge, and practices between generations has been well-documented [40, 44–46]. Furthermore, prior VR studies have shown that storytelling can create a unique sense of presence and embodiment for users within the VR environment [29, 35, 61]. In our context, the OA is asked to share one or more significant personal events from their past, for example moving to a new country or starting university. This event should be one that has had a substantial impact on their lives, holds deep personal significance, and has contributed to their personal growth or understanding of the world.

The storytelling procedure is designed to be a two-way process, with the YA asked to pose reflective questions on the OA’s story. Reflective questioning is a clinical technique commonly used to encourage practitioners to delve deeper into their thoughts and feelings about their patients’ experiences, thereby promoting greater understanding and empathy [11, 12, 75]. Likewise, after the OA shares their life experience, the YA is encouraged to formulate questions that help them analyze the OA’s past behaviors and understand the motivations behind their actions. This process aids in

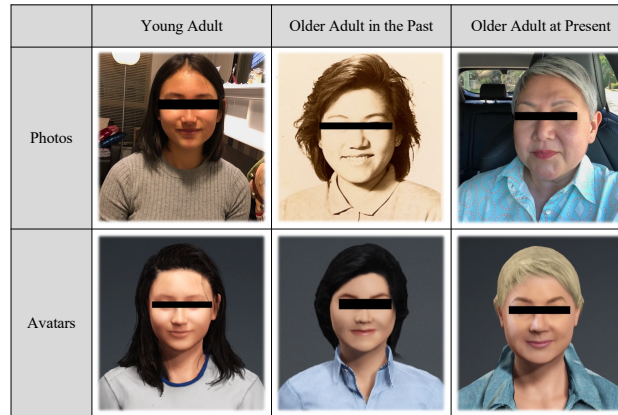


Figure 2: Avatars generated from photos of the users.

fostering a deeper understanding and empathy towards the OA’s experiences. Both the OA’s story and the YA’s reflective questions serve as catalysts for IGC and help shape the conversation within the given scenario.

To further facilitate their storytelling activity, the OA is asked to bring a photograph related to the event they are sharing. This photo serves as a visual aid to assist the OA in recounting their memory and provides a backdrop for the YA to better imagine and understand the shared experiences. As shown in Fig 1, the photo is scanned and imported into the VR environment, where it is displayed as a photo frame hanging on the wall between the users. In VR, the OA’s chair is surrounded by a series of photo thumbnails. When the OA selects a thumbnail, the photo frame updates to display the corresponding photo.

3.2.3 Role-play Protocols. To encourage the users to fully embrace the role-play setting in the perspective-taking scenario, we developed specific guidance protocols. The initial step involves priming the YA to adopt an empathetic stance towards the OA’s story. To enhance their capacity to empathize, YAs are guided to put themselves in the OAs’ shoes. The guidance script provides specific prompts such as “Imagine what OA’s might have felt like in the past” and “Consider how your own experiences might be similar to those of the OAs”. This method is derived from affective conscious empathy training [19]. Our explicit priming protocol is grounded in the design rationale that empathy is not just an inherent quality, but also a skill that can be cultivated and strengthened with deliberate training and practice [20, 50, 74].

The second step of the protocol involves the use of pronouns, which plays a performative role in the language utilized within the protocol. YAs are encouraged to consider adopting a first-person narrative style when posing questions or engaging in the dialogue. This narrative approach aims to promote deeper engagement in their role as the OA, potentially inspiring YAs to actively contribute to the storytelling scenario and facilitating their adoption of the perspective and voice of their assigned identity, thus enriching the overall narrative experience. Conversely, the OAs are advised to employ a second-person narrative style when sharing their life experiences or responding to questions. This narrative technique is

intended to draw the YA into the core of the experience, with the goal of encouraging an enhanced sense of empathy. [10, 14].

3.3 Design of the VR Environment

Our VR environment is designed to enhance participants’ sense of embodiment, involving two primary elements.

3.3.1 Use of Mirrors. Mirrors are installed in the virtual world to reflect the user’s avatar, enhancing the user’s sense of embodiment [30, 32, 69]. We acknowledge the potential negative effects a mirror can have on self-perception, as discussed by Döllinger et al. [15]. Their work emphasizes the importance of body awareness when evaluating VR designs and avatar embodiment, particularly those aimed at mental health. They suggest that even the most realistic scenarios can divert users from their internal body signals. Nevertheless, we opted for mirrors to immerse YAs in the identity of the OAs, in line with our project’s objective.

3.3.2 Mapping the Virtual Environment to the Physical Environment. To further enhance the sense of embodiment, the virtual space is intentionally designed to align with the physical room where the study is conducted [70]. Before entering the VR environment, the users are seated on two green chairs, each facing a separate mirror. A TV screen is placed between these mirrors, which corresponds to a photo frame in the virtual world. Upon entering the VR space, the users find a familiar furniture arrangement that replicates the one in the real room. Furthermore, the virtual world’s walls and carpeting mimic the colors present in the actual study room, reinforcing the connection between the two environments as depicted in Figure 4 (in appendix).

3.4 System Implementation

We used *Character Creator 4* software to generate the avatars according to the photos provided by participants, which include a clear view of their full front face. We created the VR environment using Unity, then uploaded the VR environment and avatars to the VRChat platform to save the effort of deploying the server. We used Oculus Quest 2 as the apparatus. Participants interacted with the VR system using two hand controllers.

4 METHOD

An exploratory observation study was conducted to assess the impact of varying perspective-taking scenarios and their associated design elements on IGC. Given the subjective and intricate nature of intergenerational family relationships, the study adopted a qualitative and exploratory approach to assess the influence of identity and age.

Three Perspective-Taking Scenarios: Central to our study was the assessment of perspective-taking scenarios experienced by our participants. Out of numerous potential scenarios, we zeroed in on three specific scenarios as depicted in Fig 3. The introductory scenario had participants take their own perspective and embody an avatar resembling their real-life appearance. The other two scenarios chosen were “Past Meets Future” and “OA’s Inner Monologue”, as detailed in Section 3.1.3.

4.1 Procedure

The study was composed of three key phases as shown in Figure 5 (in appendix). First, an online pre-study interview was conducted with the OA to set up the storytelling process. Next, an in-person VR session was held, during which the YA and OA were guided to use LegacySphere and experience the three perspective-taking scenarios. Finally, a post-interview was conducted to gather feedback and reflections on their experiences. The online pre-study interview lasted about 20 minutes, while the in-person VR session and post-interview, which occurred consecutively, took roughly 2 hours in total.

4.1.1 Pre-Study Interview: Preparation of Stories, Photos, and Avatars. The pre-interview phase aimed to accomplish two tasks: to understand the OA’s life experiences and to assist them in preparing for the storytelling procedure. The pre-interview was conducted with the OA by the lead investigator via Zoom. Before the Zoom session, we asked the OA participants to prepare several personal events from their 20s that were particularly impactful. These could range from singular memorable events, such as marriage, to prolonged experiences like attending university. They were also asked to prepare photos representing each life experience. During the Zoom interview, the OA was asked to share these photos and narrate the stories they represented. This process helped ensure the stories adhered to the criteria, while providing an opportunity for the OA to practice storytelling for the VR session. Participants would share their photos, which would be used to generate their avatars and configure the VR system for the upcoming stages of the study with the researchers after the pre-interview.

4.1.2 LegacySphere Experience. The dyad was invited to the lab for the VR session. After providing an overview of the study and obtaining consent, the lead investigator introduced the three scenarios, the VR environment, controller usage, and headset adjustment.

The introductory scenario was always the first to be experienced, as it helped participants familiarize themselves with the VR environment and the study structure. The second and third scenarios, “OA’s Inner Monologue” and “Past Meets Future,” were experienced in a randomized order. Five life experiences were shared by the OA throughout the study—one in the introductory scenario and two in each of the other scenarios.

Before transitioning into the second and third scenarios respectively, we implemented the immersion facilitation protocol from Section 3.2.1 and the role-play protocols from Section 3.2.3. Once participants were comfortable with the perspective-taking setup, the OA narrated their story and the YA asked reflective questions, as outlined in Section 3.2.2.

4.1.3 Post-Study Interview. The goal of the post-study interview was to collect participant feedback and reflections on their LegacySphere experience. We organized this semi-structured interview around four focal points: “VR Environment,” “Intergenerational Communication & Storytelling,” “Avatar & Perspective-Taking,” and “Future Designs.” The interview with the dyad was essentially a triadic conversation where any participant could respond to any question at any time, with a few exceptions for questions specific to one participant. This semi-structured approach allowed participants to build on each other’s answers, providing additional insights while discussing their personal experiences and emotions. The lead investigator took notes on participants’ behavior while they were in LegacySphere. The memos enabled the lead investigator to ask follow-up questions about the participants’ nonverbal cues / reactions during the VR sessions.

4.2 Participants

Our study involved five parent-child dyads, each with a generational gap (total 10 participants). Participants were recruited via convenience sampling and local community advertisements. We recruited participants with a call for participation that indicated “Connect with your older/younger family member in Virtual Reality (VR)”. We did not mention up front that LegacySphere was designed to foster empathy between generations. The recruitment process was challenging due to two main reasons: both members of a dyad needed to reside in the local community and be able to visit the lab for the VR session. Additionally, the OA needed to have at least five photos from their 20s, depicting meaningful experiences, and be comfortable with sharing them with the research team, as described in Section 4.1.1.

The group of OAs consisted of three women and two men, and the average age is 51.2, while the group of YAs comprised four women and one man, and the average age is 20. For more details, refer to Table 1.

4.3 Data Collection and Analysis

The study generated approximately 7 hours of interview recordings and 8 hours of observational video data from the VR sessions. The transcribed post-study interview recordings served as the primary data for our thematic analysis [9]. The videos were used to clarify details when needed.

The thematic analysis employed a combination of inductive and deductive coding strategies [9], with all three researchers engaged in the coding process. The process entailed several essential steps. Initially, each reviewer independently generated codes and documented preliminary interpretations from the assigned transcript, resulting in approximately 60 codes per transcript. Codes such as “avatar helps YA formulate questions” and “OA exhibits increased introspection when interacting with her younger VR self” were





Scenarios	Introductory	Past Meets Future	OA's Inner Monologue
YA's perspective	YA's self 	OA in the past 	OA at present 
OA's perspective	OA's self		

Figure 3: The three scenarios employed in our user study. The YA assumes a different perspective in each scenario. The OA embodies a perspective that represents their own identity and current age in all scenarios.

Table 1: Overview of Participant Demographics

Dyad	Role	Age	Gender	Occupation	Education	Place of Birth	Ethnicity	First Language	Years Reside in Canada
1	OA	51	Man	Engineer	PhD	South Korea	Korean	Korean	13
	YA	24	Man	Engineer	Bachelor	South Korea	Canadian	English	13
2	OA	56	Woman	Research Admin	Bachelor	Phillippines	Filipino	Cebuano	45
	YA	18	Woman	Student	High School	Canada	Asian	English	18
3	OA	55	Woman	Music Educator	Bachelor	Canada	Dutch	English	55
	YA	21	Woman	Student	High School	Canada	Canadian	English	21
4	OA	46	Man	IT Consultant	Bachelor	China (mainland)	Chinese	Cantonese	7
	YA	18	Woman	Student	High School	China (mainland)	Chinese	Cantonese	7
5	OA	48	Woman	Freelancer Writer	Master	India	Hindu	Hindi	1
	YA	19	Woman	Student	High School	India	Indian	Hindi/English	2.5

generated. These codes were then deductively grouped into categories like “avatar”, “OA and YA conversation,” and “self-reflection”. To assess the effectiveness of LegacySphere in enhancing intergenerational communication and empathy, we analyze the statements where participants express an increase in empathy, transparency, or reflectiveness in their interactions. We used codes such as “Emotional Understanding”, “Perspective-Taking” and “Self-Awareness” Lastly, relationships between categories were used to develop a set of themes encompassing both deductive and inductive categories, resulting in a total of 30 categories. This comprehensive approach enriched the extraction of meaningful insights from the post-interview data.

4.4 Positionality Statement

The research team recognizes the potential for our personal genders, cultural backgrounds, and social identities to introduce biases into this study. Within our trio, two researchers identify as women and one as a man. Ethnically, two of us are of Asian descent, while the third is of White descent. On the dimension of family experience, two of us are parents, whereas one is not. Our preliminary understanding of IGC is rooted in how individuals in our respective

cultures relate to older family members, predisposing us to believe that empathy towards the past experiences of one’s older family members can fortify their relationships. We are situated in a multi-cultural city in a developed country. We acknowledge that many of our participants are immigrant families where there’s a particular IGC challenges due to the cultural clashes between the 1st and 2nd generation immigrants in the same family.

5 FINDINGS

We first present the observed impacts of alternative embodiment brought about by the avatars and role-play on each participant individually. Subsequently, we outline the influence of the LegacySphere experience on the communication dynamics when two participants engage with each other. We then focus on how the dyads develop new insights and understandings of the OA’s past experiences, potentially fostering greater transparency and empathy in their future interactions.

In this section, when referring to a specific participant, we employ the naming convention “[OA or YA][# dyad].” For example, “OA4” denotes the older adult in Dyad 4.

5.1 How Alternative Embodiment Impacts Individuals

The immersive experience of perspective-taking arises from the combined effect of avatars and role-play. Young adult participants blend their understanding of their embodied selves with real-life experiences, resulting in the emergence of reflective questions and a deeper understanding of the experiences from both perspectives. Simultaneously, as the OA observes their younger self in old photographs seated beside them, the OA's imagination is triggered by numerous memories from their own youth.

5.1.1 Immersive Perspective Taking Under the Impact of Avatars and Role-play guidance. All the YA participants unanimously agreed that the avatars played a crucial role in helping them adapt to their new identities in “Past Meets Future” scenario and “OA's Inner Monologue” scenario. YA5 specifically mentioned, *“I think it [the avatar] is the factor that impacts the most. Just looking in the mirror helped a lot, like seeing my avatar and knowing who I am supposed to be in this scenario. So that was very helpful. So I can speak to her like that.”*

The immersive experience facilitated by OAs' avatars triggers the YAs' imagination on perspective taking, regarding how the OAs would behave and think at different stages of their lives. Some participants suggested that the avatar helped them to imagine themselves in the role, as mentioned by YA5, *“I think it would be a lot more difficult to think of myself as the younger her (without the avatar)... but then in VR our avatars are very similar as like her younger self, it's a lot more easier to put myself in those shoes while my hands are connected to me and like all of that, it's a lot more easier to be like the younger [OA] and then also think like the younger [OA].”* YA3 and YA4 made similar comments that echo YA5's point above.

One of the effects of avatar-based perspective-taking was assisting YAs in formulating reflective questions. The YAs found it helpful to create reflective questions tailored to the role they were embodied in by observing the avatar. YA4 noted that the avatar assisted her in generating reflective questions correspond to the role she was playing as, *“When I ask questions, there are times when I look into the mirror and then when I see that I am exactly the same as you, I feel like I know what to ask as being you.”* Similarly, YA5 experienced a similar impact through the avatar in asking reflective questions, *“Every time I'd like to speak or ask a question I would look at myself in the mirror. Remember who I am like, which part I'm playing right now and then ask the question like.”*

Avatar-based perspective-taking also had the effect of heightening YAs' sensitivity to OAs' emotional experiences. YAs became more attuned to the OAs' emotional experiences when they were embodied in the OAs' avatars, as indicated by the type of questions they asked. Instead of simply inquiring about what happened, the YAs were encouraged to approach their questioning from the OA's perspective, gaining a deeper insight into the OA's emotional experiences. When YA3 and her mother talked about her mother's past experiences in the physical world, her questions focused on factual details. YA3 said *“I've never asked her reflective questions like that. When we talked about the experience before and I asked questions, I usually be like, oh, who was that or what were you doing there? Where was this?”* Through the immersive perspective taking, YA3 become attentive to the OA's feelings. Immersed in the OA's

perspective, she asked questions like, *“what do I feel about omma (grandmother)?”* This shift demonstrated her heightened sensitivity towards understanding the OA's emotional state rather than solely focusing on the events that transpired. YA2 also shared her experience of immersing into the OA's perspective and asking questions about the OA's feelings: *“I was sort of asking questions in her perspective. I think that was making me ask questions like, how did you feel or like, how did I feel? I think it did contribute to empathizing with her.”* She recognized the role of immersive questioning in developing empathy and gaining a deeper understanding of OA's experiences.

5.1.2 Younger Adults Blending Real-Self and Embodied-Self. In this section, we present how YAs blended their real-self with their embodied-self to engage in perspective-taking. The term “blending” refers to YAs attempting to adopt the identity of their embodied-self while drawing from their knowledge and experiences as their real-self, such as incorporating their own experiences and the personalities of the OAs in the present while considering the social context of the past at the same time. By blending these different aspects of themselves and amalgamating various approaches, YAs aimed to portray the OAs and gain a deeper, more comprehensive, and empathetic understanding of their perspectives and experiences. We have identified four distinct patterns that contribute to this theme.

One way YAs achieved the blending effect in the “Past Meets Future” scenario was by projecting how they feel about themselves onto what OA would have felt. It is important to note that all of the YAs in this study fall within the age group of 18-25. This age alignment between YA's current age and OA's age in their photo influenced their assumptions about the OAs. For example, some YAs felt that they themselves were naive at their age, and they assumed that the OA they embodied also felt naive during that age. YA5 tried to think of what the OA would have thought when she was 20 years old, *“For scenario 2 [Past Meets Future]. I felt a little constricted and more naive like OK, I don't know what's happening. Like, you know, I don't know anything about the life right now.”* YA3 held the belief that both she and the OA were naive during their twenties. This common ground served as a basis for her to speculate about the OA's thoughts and experiences, *“The younger self is acting more naive. Because I'm your younger self... but I kind of was as well, as we are all naive when we're younger.”*

Another approach utilized by YAs in the “Past Meets Future” scenario was to draw from their understanding of the different social norms between the present and the past. They would then take into careful consideration the social context that existed during the time when the OA they were embodying was in their twenties. When attempting to portray the role of her mother, YA5 incorporated her understanding of how women were treated in the country where her mother grew up back in those days, stating, *“If I try to relate to myself nowadays, it wouldn't apply right because a lot of the things are different, like the societal pressure of doing a solo trip. It's OK for us now to do solo trips, but back to then it was a big deal.”* YA5 could sympathize with the OA's decisions given the circumstances that she was situated in, *“It was nice to think of myself as somebody in the old time and think of what things could bind me where I couldn't go and could go.”*

For the “OA’s Inner Monologue” scenario, some YAs blended their understanding of their OA from their daily observations and behaviors into the role-playing. This approach enabled the YAs to speculate about the thoughts and inner experiences of the OAs. YA4 made an effort to place herself in her father’s perspective, taking into account his characteristics and mindset based on her understanding of him in the scenario of “OA’s Inner Monologue”, “*I started by listening to his story and then treating it as if this was my own story that was happening. I need to think with him and substitute his perspective. I did think about it in terms of his character.*”

5.1.3 Two Mechanisms for Reminiscence of the OA’s Past: Memory Association and Imaginative Recollection. OAs were prompted to recall and envision their younger selves in the “Past Meets Future” scenario. Their memories became more than mere recollections of specific stories. They also imagined the mindset and personality of their younger selves during the conversation with the YA embodied in their “younger self” avatar.

When discussing how to communicate with their younger selves, OA3 mentioned that she would “*put herself into a mind frame*”, a memory recall that was triggered by the combined effect of seeing her younger self in photographs and having the avatar of her younger self sitting next to her, “*I think it’s sort of like looking back, recalling the pieces of the memory. But then having this virtual reality, this image, this avatar, made those memories more vivid. It seemed to stimulate my mind, making me want to breathe life into those images and transform them into a more vivid story.*”

When OAs were asked to treat YAs as their younger selves, they looked at the YA sitting next to them, who was embodied in their younger avatar, and also looked at the photos provided. This process served as a trigger, stimulating their imagination of what they would have thought at the time. While sharing her past stories with the YA as her younger self, OA5 felt she was not just recounting her experiences but also imagining her thought process from her younger years. It was more than just a recovery of memory; it involved visualizing her past self, including how she would think and behave when she was young, “*for me it was like sharing my experiences to my imagined younger self. You can see that there is this woman, she’s in a similar state to me. What was she thinking? What were our times? What were our society pressures? What were our inhibitions and what we want from our life?*” By visually connecting with the younger avatar and the photos, the OAs were able to transport themselves back to their own past experiences and emotions, allowing them to reflect on their own life journey and the passage of time.

5.2 How Alternative Embodiment Enhances Intergenerational Communication between Older Adults and Younger Adults

The immersive perspective-taking experience influenced the dynamics of interactions within the dyads. By discarding the parent-child dynamic, the participants were able to engage in a more transparent and reflective communication. The usage of pronoun also led to a strengthened sense of unity between the OA and YA.

5.2.1 Relationship Cushioning. LegacySphere created a safe space for participants to more freely express their deep emotions and

feelings. The parents-children identities can sometimes create limitations in communication. The family member may wish to protect their privacy, steer clear of potential conflicts or disruptions that could result from story sharing, and might feel vulnerable to reveal deeper layers of self-disclosure. For example, the parent-child relationship may be characterized by established roles and expectations, where parents are seen as authority figures, and children may feel the need to seek approval or conform to certain behaviors [21]. An alternative embodiment provided by LegacySphere gives an opportunity for participants to mitigate these barriers and engage in more transparent communication. As mentioned by OA1, “*I felt more comfortable to talk about my personal feelings here. I think it’s because it’s like another world. In the real life, when we talk to each other, I feel more like shy and a little bit less comfortable.*”

YA2, YA4, and YA5 all highlighted that LegacySphere allowed them to communicate with their parents as equals rather than in a parental role, enabling them to express their opinions more assertively. As mentioned by YA4, “*having a different perspective and questioning our dad can actually be quite enjoyable. I can ask the questions that I don’t feel proper to ask in daily life.*” YA5 provided advice to their OA in an assertive manner when embodying the OA’s current avatar. When asked by the researcher if she would employ the same approach to give advice to the OA in real life, she responded, “*Probably not as strongly as how I was like, straight up telling her that, OK, do this now. I would probably just be like, you should probably do this, but I wouldn’t be as strongly worded.*”

Likewise, OAs found themselves on equal footing when communicating with the YAs in LegacySphere, leading to greater transparency in their conversations. As mentioned by OA1, “*I feel safe to talk about anything with myself.*” YA5’s responses and input appeared to have triggered self-reflection in OA5. This was facilitated by OA5 treating their other self more as an equal, resulting in a greater willingness to accept suggestions and perspectives offered by YA5. As mentioned by OA5, “*I have got a good friend [the YA]. And you can say she can be a mentor for me for the rest of my life.*” But OA5 indicated that if YA5 expressed their comments in such a strong way in reality, “*it would be quite different. Actually I can scold her.*” OA5 laughed.

Some OAs expressed that they felt more comfortable sharing their hidden feelings during the alternative embodiment, as they believed they wouldn’t face judgment from their other self. In the words of OA3:

“I felt a little bit more freedom. As her mother, I might be a bit more guarded. In VR but I didn’t feel that I had to be. So there was a little bit more freedom to respond with transparency...I feel like I want to keep some things to myself in reality, but in the virtual environment, I didn’t feel like I really had that choice. Like, I felt like I should honestly answer. Because there wasn’t gonna be any judgment. There wasn’t gonna be any judgment from my younger self. How is she going to judge her older self? But sometimes in a mother and daughter relationship, there is some judgment.”

For some OAs, the avatar enabled them to express their emotions and engage in meaningful conversations and reflections with the YAs by concealing their facial expressions and by not being able to

see the faces of others. OA2 likened the experience to a confession, stating, *“so when you go to confession. The priest sits and you don't see the priest. So then you confess your sins and so. You feel more comfortable doing that because you don't actually see the person, right?”*

5.2.2 “I,” “You,” and “Us”: How Differing Pronoun Usage Invokes Embodiment, Empathy, and Unity. Our observation and participants' reflection on the pronoun used in their conversation revealed that the pronoun use not only captured the relationship shift during the session but also fostered a greater emotional connection between the YA and the OA. Three instances of unconventional pronoun uses were noteworthy.

When YAs referred to themselves using the first-person pronoun (‘I’) while embodying the identity of the OA, it served as an additional aid in the process of fully immersing themselves in the OA's identity. YA4 suggested that asking questions in the first person narrative enhanced the sense of embodying the OA's identity, *“After I ask these questions, I feel like I know him better. Cause I respond to the story and raise questions, but I was using I, it feels like it was my father asking himself instead of me asking. But I look like Jimmy, I feel I am him.”*

When YAs utilized first-person narratives, which were using ‘I’ when referring to the OA in the story, they experienced a greater sense of ease in asking reflective questions and guiding the OA to articulate additional details. YA3 explained that when using first-person narratives, it reminded her of the ways she would use when reflecting on her actual self. This made the process more intuitive and natural for her. She said, *“It's easier to ask or to think of questions when using ‘I’ in self-reflection. When you're using ‘I’, it feels like a form of self-reflection, and questions naturally arise, similar to when you're reflecting on your own experiences. So, then it was like I was truly reflecting on myself because I was using, ‘I.’”* YA2 suggested the same idea, *“I can think more like him [by using ‘I’]. I can ask the right questions to find out more about the experience that I don't know.”*

When the OAs used second-person pronoun (‘You’) to refer to themselves enacted by YA, they found it more natural to express their emotion by externalizing their identity. During the interview, when OA2 discussed her experience with miscarriages, she became emotional and started crying. YA2 mentioned that she had heard about the story from OA2 before, and suggested that the OA's emotional response during this instance was due to her use of the second-person narrative, *“I think the way that she was narrating the stories, that's why she started crying. I've never heard you say it in a second person perspective before.”*

During the study, YA5 and OA5 experienced a natural shift in their language usage, transitioning from using first and second person narratives to incorporating the first-person plural pronoun (‘us.’) This unprompted linguistic change reflected their growing perception of themselves as one cohesive entity. As OA5 expressed, *“She is the younger and I am the older version, we are ‘us.’ Half holding hands together and talking about the younger one.”* YA5 took the OA5's experience as her own experiences and brought herself into it, stating, *“I think in the VR it was, it felt more like she's talking about ‘us’ together. At least I was also doing that sometimes. Like I was talking about ‘us’... It felt like I was walking like me. I was walking*

down the road, and she's just telling me what I am doing.” This shift in language usage and the shared sense of decision-making demonstrated that the participants started to perceive themselves as a unified entity, transcending the boundaries of their individual identities. It fostered a deeper connection between the YA and OA, creating a sense of shared experiences and a shared narrative.

5.2.3 New Stories, as well as New Perspective to Known Stories . The experience sharing within LegacySphere appeared to provide the potential to uncover a new perspective on stories that the YA already knows. First, the conversation in the VR space facilitated the exploration of topics that may be uncomfortable to address in real life. For instance, YA2 mentioned that she and her mom would never talk about how much her dad sacrificed for the family, except in the VR environment. She shared, *“You also talked about how dad sacrificed a lot for the both of us. That's something that I never think about, and we never talked about how much my dad has done for us.”* This revelation impacted her perspective of their relationship with her dad. She believed that LegacySphere would change her point of view. In real-life conversations, she and her mom would often complain about her dad, *“I honestly think that it (the system) is going to change my perspective on our relationship with my dad. Because in real life, conversations are like, oh, my God, my dad literally sucks, and then my mom will contribute to them, feed off of them.”* However, through LegacySphere, her mother shared with her the efforts her dad had made to keep their family happy and support her mom's decisions, something her mother had never spoken about in real life, *“But now I knew that he's really done so much to make us happy, make you happy. Just go along with whatever you want to do and then he doesn't complain. And like he complains about other stuff, but not the stuff actually matters.”* Second, the conversation went deeper and some YAs seemed to gain more insights by listening to the story from a different perspective, even if they already knew the stories. When taking on the role of the OA and listening to the story, YA3 experienced a perspective shift, which changed her perception of a story she was already familiar with, *“When I see the photos as myself, I think about where I am in relation to that, but seeing it as the OA, I'm not seeing it in relation to Joe [the YA herself]. It provided me a new perspective”*

5.3 A Co-Created New Perspective on the Older Adult's Past Experience

By allowing the YAs to retain part of their real selves while embodying the role of the OA, unique viewpoints were brought into the interactions. As a result of these constructive discussions, the dyads arrived at new insights and understandings, suggesting greater transparency and empathy in their future interactions.

5.3.1 Enhanced Self-Understanding and Self-Reflection. LegacySphere stimulated self-understanding and self-reflection among participants through various means. YAs recognized similarities with the OAs and gained insights into their future selves by observing the OAs' journeys. OAs revisited their past lives by narrating their experiences to their younger selves. The comments from the YAs, who played the role of OA, served as catalysts for self-reflection among the OAs.

By embodying the OAs' avatars, the YAs became more sensitive to their similarities with the OAs, from appearance to personality, which encouraged them to compare their personal development plan with the OAs' past experiences. YA4 noticed many similarities between herself and her mother's younger self. She felt that by learning about what her mother was like at her age, she was also gaining insights into her potential future self. She expressed this by saying, "I think her (the OA's) younger self was pretty much like me right now. I'm learning more about my future self when learning about my mom."

Talking to another self allowed the OAs to review their past life experiences and the decisions they made. OAs valued and appreciated the diverse perspectives and input that YAs offered when they inhabited the avatars of OAs, as it stimulated self-reflection and personal growth among the OAs. As mentioned by OA2, "It is good for you to see your younger self as you were telling the story. I think I have benefited from telling the story by looking at myself who was actually doing those things." When OA5 answered the reflective questions posed by YA5 who embodied her younger avatar, the viewpoints and perspectives of the YA triggered the OA's thoughts regarding certain decisions she had made, "As [YA] being my younger self, I was looking at myself [at] that time and thinking 'why haven't I done what you said in my time', like when I was young, why was I thinking like in such a way, not the other way". OA5 further explained how YA5 helped her in reflecting on her past actions, saying, "she (YA) can relate to the experience, and asking 'why have I done this?', which made me realize I could have done it in a different way."

Different OAs hold different attitudes toward their younger selves. Some OAs choose to preserve certain information that their younger selves were unaware of, in an effort to help their younger selves fully live in the moment. "I didn't try to launch it into the future too much...I felt like I wanted to let the younger self live in the moment. A bit more." On the other hand, some OAs made an effort to communicate with their younger selves as experienced individuals, sharing the wisdom and insights they wish they had possessed at that time. As mentioned by OA2, she wished that she could do something for her younger self, "It's kind of like, this is what I wish I had done and which is what I'm doing now for you."

5.3.2 Enhanced Comprehension of Aging while Simultaneously Alleviating the Associated Stress. Some participants found great value in experiencing "Past Meets Future" before "OA's Inner Monologue". The ordering of the scenarios seemed to prompt contemplation on the process of aging and its implications.

Before the VR study commenced, OA5 examined the images of her avatars in the role-playing guidance and sighed, remarking on how attractive she was during her youth compared to her present appearance. During the interview, when the researcher inquired about the comparison between the "OA's Inner Monologue" scenario and the "Past Meets Future" scenario, the first aspect the OA addressed was the avatar, "The younger version was beautiful", she said.

When the researcher asked her how she thought about the sequence of scenarios, OA5 said she experienced a greater sense of relief regarding the process of aging. "Aging is only related to your physical strength coming down, not your mentally. Mentally, you are

much stronger. You are much mature...The limitation is only physical, not mentally." The suggestions she received from her younger self, which was YA5 during the role-play, influenced the way OA5 contemplated her present life, "[the reflective questions] make me feel like I never try to change my perspective about life, and obviously this study would help me realize that I can still change my, things. I can still do more things."

As a young adult approaching the age of 20, YA5 began to feel concerned about the pressures associated with entering adulthood and the process of aging, "To me, as somebody who's still like 19 turning 20, it's scary right now. Because I am in my teens and like in like 4 months, I will be. I'll be 20, which is out of the teens...And like you know, all the societal pressure comes up." She expressed her feelings upon witnessing the everyday life of the OA, saying "I'm going to be there." So you can see how she is currently constrained by her reality. I will probably be there at some point, and I don't know if I like that." However, after being embodied in the young OA and then transitioning to the current OA, she appeared to develop a sense of confidence from OA's life journey, "Yeah, it definitely does help. It feels like with more experience, you get more confident. At least I know that she does look more confident now. Like she's lived through everything. She knows what's going to happen like, you know, more strong and she can face anything."

Through their immersion in both the younger OA and current OA roles, some YAs gained a comprehension of the OA's aspirations in their younger years, as well as the journey that led them to their present self. As mentioned by YA1, "throughout the experience, with scenario one [the introductory scenario] and two [Past Meets Future scenario], I learned a lot and when I went all the way to scenario three [OA's Inner Monologue scenario] and I am now himself, I think I was able to have a bit more data to act like him and feel more like him. I was able to actually say something that I felt he would. So I kind of was able to feel more empathy toward him at the very end." YA5 felt that embodying the role of the OA from both the past and present allowed her to gain a deeper understanding of the OA. As a result, she expressed confidence in her ability to provide improved suggestions and guidance to the OA, "I see her journey and what all she's done and what she wants to do... [and] giving her advice on how she can do it now."

5.3.3 Indications of Greater Transparency and Empathy in the Future. All the participants, both YAs and OAs, expressed the belief that the immersive experience would lead to increased transparency and openness in their future interactions. LegacySphere seemed to offer them a fresh perspective on intergenerational communication (IGC), potentially encouraging them to be more open and engaged with each other. YA4 remarked on how their own focus on their feelings diminished, as they began to understand the OA's perspective and the sacrifices they made for the family, "It's become clear to me that we've been ignoring my father's emotions for quite some time, and unfortunately, he himself seems to be doing the same. He never speaks about his own perspective or experiences in the matter."

The use of LegacySphere within the family context may foster improved communication by enabling family members to see things from each other's perspectives. The immersive experience offered by VR allows parents and children to empathize with one another, bridging significant gaps that may exist in understanding. As OA1

reflected, “*We have very, very big gaps in many cases, and we need more opportunities to talk. We usually try to converse during meals or breaks, but this method [LegacySphere] may be better. It helps my child think from my perspective*”.

6 DISCUSSION

In the findings section, we presented how LegacySphere’s enhanced communication impacted intergenerational communication (IGC) and personal growth. In this section, we delve deeper into the reasons behind these impacts and discuss the design recommendations based on our findings.

6.1 How Various Design Components Contribute to Empathy

Our findings contribute additional evidence to support the existence of the Proteus Effect and illustrate its potential advantages in enhancing IGC. We observed that YAs fully immersed themselves in the perspective of the OAs, leading to a heightened awareness of the OAs’ emotional states. YAs also experienced a strong sense of connection and identity with the OAs. This deep understanding enabled YAs to ask insightful questions that directly addressed the OAs’ viewpoints, encouraging thoughtful reflections from the OAs.

Our findings add new insights on how to design VR experiences that aim to invoke YAs’ empathy towards OAs. There are two types of empathy, cognitive and emotional. We observed evidence of both types of empathy displayed by YAs towards the OAs. The designed components of LegacySphere appeared to have a collective influence on participants throughout the study. As mentioned in previous research [34, 81], emotional empathy may increase while cognitive empathy may decline as people age. While it is not possible to definitively attribute specific design elements in LegacySphere to cognitive or emotional empathy, we believe it is valuable to explore which elements are more likely to impact each type of empathy. This exploration may benefit future VR experience designs for enhancing IGC.

6.1.1 The use of avatars, role-play, and reflective questioning may enhance YAs’ cognitive empathy towards OAs. Perspective-taking enhances cognitive empathy. Cognitive empathy is more about intellectual understanding rather than experiencing the emotions firsthand. The avatar serves as an effective tool for YAs to step into the shoes of the OAs, enabling them to overlook apparent differences that might otherwise hinder this immersion. Guided role-play further enriches this process by leading YAs to observe and scrutinize the experiences and emotions of the OAs. It provides a structured approach to experience and analyze the emotional landscape of the OA, thereby fostering cognitive empathy. The application of reflective questions compels YAs to analyze the emotions and motivations underlying the behaviors of the OAs. This introspective practice is supported by the literature [11, 12, 75]. When YAs posed questions, they became more conscious of the emotional state of the OAs. They learned to formulate questions from the perspective of OA, thereby gaining valuable insights into their emotional experiences.

6.1.2 Engaging in storytelling and interactive conversation when YAs are embodied in the OAs’ avatar allows YAs to more directly experience the emotions of OAs, which may enhance YAs’ emotional empathy. Listeners of a story can emotionally immerse themselves within the narrative, a process that notably enhances empathy. This phenomenon is known as “emotional transportation”. When a YA embodies the avatar of an OA and observes the OA’s image in a photograph connected to the narrated story, the emotional transportation may be even stronger. This visual reinforcement aids in aligning the YA’s perspective more closely with that of the OA, making the process of emotional transportation more immediate and tangible. Furthermore, conversations that transpire between OAs and YAs in the VR space may also trigger the YAs’ emotional empathy [66]. OAs may express strong feelings in a VR environment, the feelings they would generally avoid sharing in real-life circumstances. The virtual space, therefore, provides a unique platform for heightened emotional expression, which may further stimulate the emotional empathy of YAs.

6.2 Design Recommendations

Drawing from our findings and relevant theories concerning the design of VR experiences for enhancing IGC, we present three design recommendations. By considering these design recommendations, developers may explore ways to create more impactful and transformative VR experiences that have the potential to facilitate deeper intergenerational connections.

6.2.1 Design Recommendation 1: Allow for avatar imperfections, which can be conducive to communication and reflection. We advise against solely aiming for a perfectly immersive embodiment through high-fidelity avatar implementation. An imperfect avatar offers a unique vantage point, creating a space where participants can comfortably explore new conversation topics unbounded by the limitations of real-life relationships. For OAs, hiding expressions can create a secure environment in which they feel more comfortable sharing their emotions. The avatar-based interaction provided an opportunity for some participants to express deeper emotions, made possible by the concealment of facial expressions and the inability to see the faces of others. Partial immersion in the avatar’s role allows individuals to incorporate their own perspectives into the narrative, which results in deeper reflection and a fresh interpretation of the story. Full immersion in the avatar’s role might hinder them from integrating their original identity with the avatar’s. For YAs, hiding expressions allows them to focus more on internal reflection rather than being overly concerned about how to act like an OA. They can gain deeper insights into the experiences and perspectives of the OAs. Since our primary objective is to enhance intergenerational communication, we believe it’s acceptable to slightly reduce empathy levels when using imperfect avatars if this trade-off results in more meaningful reflection and deeper communication. Previous research has also shown that high-fidelity avatars in social VR, which look similar to the user and are rendered through a 3D scanning technology, can result in the uncanny valley effect [63, 65]. Avoiding using high-fidelity avatars in the conversation may also prevent the uncanny valley effect.

6.2.2 Design Recommendation 2: Involve design elements which lead to a co-created perspective on an OA's past experience. Our research not only aims to foster empathy in YAs but also encourages them to provide thought-provoking responses to OA's past experiences, leading to personal growth for both YAs and OAs. From what we observed, we recommend the researcher consider striking a balance between encouraging participants to immerse themselves into their roles and allowing them to retain their opinions as their real-self. We used several strategies: 1) In designing the role-play guidance, we maintained a level of vagueness in the instructions, encouraging participants to interpret and play their roles based on their understanding of each other from their real-life context, rather than strictly adhering to a specified script; 2) We refrained from setting criteria or benchmarks to judge whether participants played their roles "correctly". This intentional absence of judgment fosters a more genuine expression of thoughts and emotions during role-play; 3) We encouraged participants to ask reflective questions which served as a method to stimulate the YAs' cognitive empathy and to initiate meaningful conversation.

6.2.3 Design Recommendation 3: Enrich the experience through multiple avatars and chronological narration. We investigated the impact of two design dimensions of avatars, namely identity and age. Based on our findings, we propose that these design dimensions can be extended to encompass both OAs and YAs. We recommend the following: 1) Allow *both* YAs and OAs to experience multiple avatars and explore different pairings of scenarios. Our OA2 expressed a desire to embody her younger self and share stories from her youth with the YA. This could lead to valuable self-reflection for OAs and an overall richer experience for OAs; 2) Begin by having the OA embody their own younger avatar and narrate past experiences to the YA, in order to deepen the YA's understanding of the OA's life journey. Next, have the OA switch their avatars to correspond with the specific experiences being discussed. In turn, the YA can embody different avatars representing the OA at various stages of life in chronological order. Both YA1 and YA5 agreed that such order would improve the chronological understanding of the OA's journey, and enable a deeper comprehension of the aging process, as well as the transformations that occurred in the OA's life over time.

6.3 Desired Enhancements and Addressing Potential Challenges

In addition to exploring the possible benefits of alternative embodiment for IGC and relationships, we also inquired about potential challenges and desired enhancements that participants wished to see in LegacySphere. By addressing these challenges and incorporating desired enhancements, we can further refine LegacySphere to better meet the needs and expectations of the participants.

Some OAs expressed a desire to have the opportunity to embody their younger avatars and narrate stories from alternative perspectives. Since the OAs were always depicted through avatars reflecting their current selves, some OAs noted that they did not perceive significant differences between the "Past Meets Future" and "OA's Inner Monologue" scenarios. OA4 mentioned that this is because his avatar remained static throughout the experience

and didn't change between scenarios, *"My avatar stayed still, and it didn't make a difference to me."*

Participants desired for a higher fidelity system for greater immersion and verisimilitude via a better body tracking system and more immersive experience. OA2 noted that there were moments when the appearance of the avatar seemed unusual to her, which might have momentarily diverted her attention while narrating the story, *"When you move on the chair, the avatar is doing something wonky. It's funny, right?"*

7 LIMITATIONS AND FUTURE WORK

Recruiting participants for our study had significant challenges. Initially, our aim was to study a two-generation gap, but after being unable to recruit any dyads in over one month, we shifted our focus to a one-generation gap. The recruitment remained slow. To form a valid dyad, both participants had to be able to attend an in-person virtual reality session at our lab. Additionally, older adults were required to provide a clear, full-frontal face photo to create an avatar representing their younger selves. Digital photographs did not exist when our OAs were in their 20s. It took 6 months to recruit 5 dyads; 3 of which are from researchers' personal networks. Future work should allow for a more extended period of participant recruitment and could additionally broaden the scope by including dyads from a diverse range of intergenerational relationships, thereby enriching the data and insights. Another limitation was the visual fidelity of some avatars. We created the avatars based on photos supplied by the participants, but given their difficulty locating a high-quality photo from their younger years some avatars didn't meet our ideal standards. We may investigate how the quality of an avatar influences the IGC experiences in future research.

We also acknowledge that our experience design and our study protocol do not allow us to tease apart the impact of the different design elements of LegacySphere, but rather to assess them as a whole. For example, we cannot precisely distinguish the impact of simply being in VR from the elements we designed to evoke the Proteus Effect. Future work is needed to assess the extent to which each of the design elements (e.g., storytelling vs. avatars) contributes to our findings. Out of the 10 participants, YA1 noted the consistency between the voice and the avatar. Future research should also investigate voice conversion techniques [49] to understand the impact of aligning participants' voices more closely with their avatars on participant experience. While prior studies exploring the Proteus effect in VR, researchers did not modify voices to align with avatars [71, 78], it would be interesting to understand the impact of aligning participants' voices more closely with their avatars on participant experience. Lastly, it will be important to investigate the long-term effects of interacting within LegacySphere on participants.

8 CONCLUSION

We designed, developed, and assessed LegacySphere to enhance intergenerational communication grounded in the Proteus Effect. LegacySphere aims to improve YAs' understanding and empathy towards the past experiences and emotions of older family members, with the expectation that it will lead to better communication between generations. YAs embody their OAs' avatars representing different ages; and role-play exercises, storytelling, and reflective

questions are used to facilitate mutual understanding. Ten participants (5 one-generation dyads) engaged with LegacySphere and provided feedback via semi-structured interviews. We learned how LegacySphere appears to support both cognitive and emotional empathy, and we provide three design recommendations for future VR experiences intended to improve intergenerational communication through the facilitation of identity shifts. The most formidable demographic challenge facing the world today is the aging population [6]. Strengthening IGC is one important step towards navigating the difficult socio-economic decisions that lie ahead in a way that older adults feel that they are heard and valued.

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A VR ENVIRONMENT

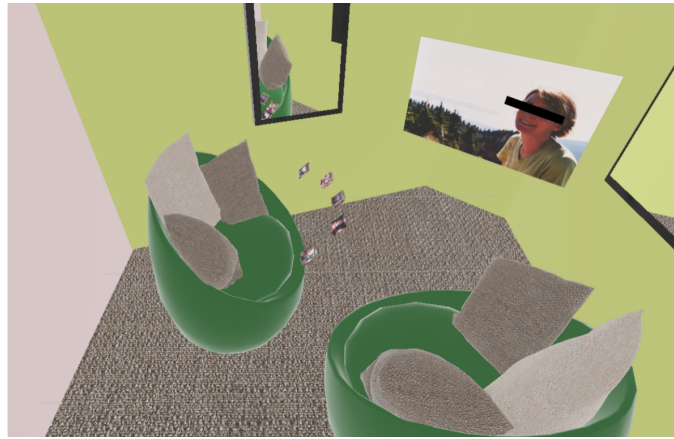


Figure 4: The VR environment

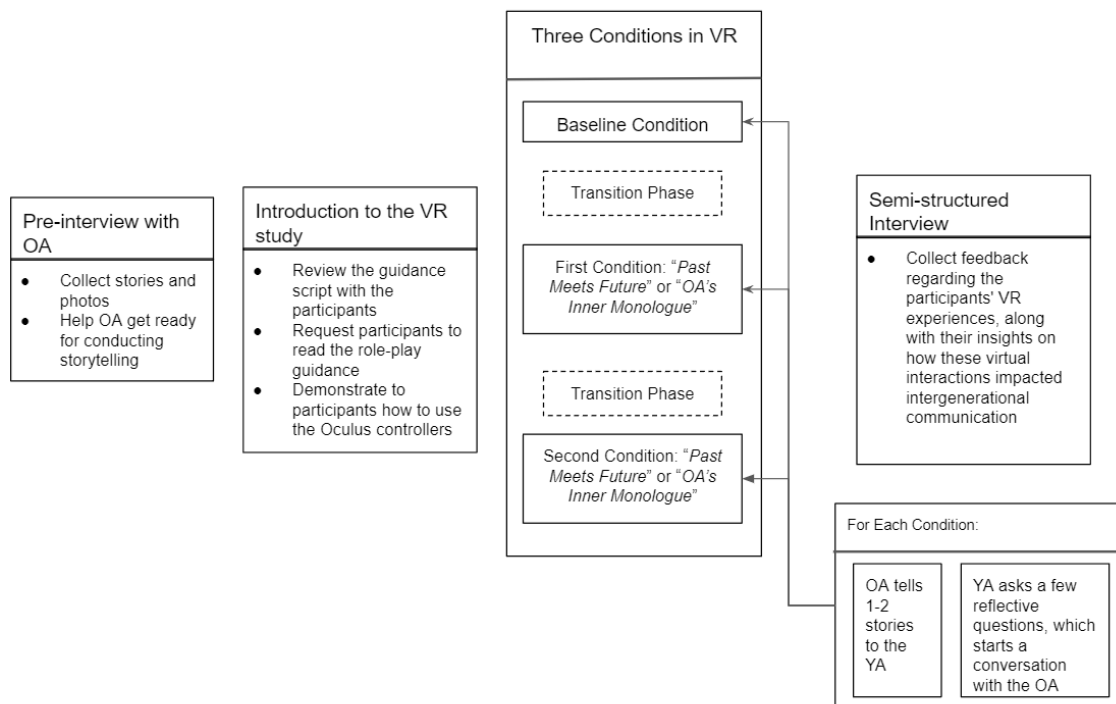


Figure 5: Procedure of the VR study.