

# "Say Bye for Hi": XR Mourning Ritual with AI-Powered Avatars in the Aftermath of a National Tragedy

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## Abstract

*Advanced technologies not only produce external transformations in society but also elicit significant emotional responses in individuals. Immersive psychological technology, which leverages the cognitive effects of Extended Reality, Artificial Intelligence, and Virtual Twin Avatars, is the methodology adopted by SITH (Self-Insight Therapy), based on Gestalt psychotherapy—a therapeutic approach emphasizing ‘here-and-now’ awareness and ‘human-in-the-loop’—serves as a prominent example. This study presents a case study of XR-based mourning ritual service leveraging immersive psychological technology to support bereaved family members in coping with grief after a tragic aircraft disaster in South Korea in December 2024. The findings illustrate how technology can facilitate safe third-party intervention in the grief recovery process for individuals who have lost family members. The XR-based mourning ritual case study, combined with an interview with a bereaved family member, indicates a promising direction for advancing traditional healing methods through immersive psychological technology integration.*

**Index Term** - Virtual Reality, XR Mourning Ritual, Virtual Twin Avatar, Gestalt Therapy, Immersive Psychological Technology, Bereaved Family

## Introduction

In recent years, the extended reality (XR) technology in various fields, such as psychology and therapy, has relied on the cognitive effects resulting from interactions in immersive environments [1], [2]. Furthermore, artificial intelligence (AI) has reshaped human society, profoundly affecting creation [3], [4], [5], communication [6], [7], memory, and even the experience of grief [8], [9]. The use of these technologies should not only focus on their application; it must also be accompanied by thoughtful consideration and an ethical review of how and where they are implemented.

The term Immersive Psychological Technology (IPT) refers to beneficial applications that enhance cognition through human-computer interaction (HCI) in immersive environments. IPT incorporates three core technologies: XR, AI, and virtual twin avatars (VTA). With the emergence of immersive virtual reality (IVR), the concepts of presence [1], [10] and embodiment [11], [12] have become central to the field. These concepts are often described as "being there [13]" and "being there with [14]." In the context of IPT, AI analyzes user behavior by monitoring psychological states, movements, and physiological signals. VTAs engage users in a way that feels realistic and immersive. To create a convincing sense of presence, it is essential to have an AI-powered 3D digital human that can interact through both verbal and non-verbal communication [15], [16], [17] as a VTA in the user's personal context.

Founded in 2023 (Korean business registration No. 2878802826), VHEX Lab was recognized with a CES 2025 Innovation Award in the Digital Health category for its product SITH: Self-Insight Therapy [18]. This innovative multi-device XR therapy platform is designed to operate across both PCs and head-mounted displays (HMDs). Grounded in Gestalt Therapy [19], the SITH platform utilizes immersive versions of the empty-chair and two-chair techniques. As technology continues to advance, it further connects our world and increasingly influences art, culture, and the emotional aspects of human life. A year later, the company received the CES 2026 innovation award in the same category, with the new service SITH.XRaedo focuses on mental care for bereaved families who lost their loved ones through an XR-based mourning ritual, aiming to prevent the families' complex grief symptoms [20].

In December 2024, an airplane crash en route to Muan Airport in South Korea claimed the lives of 179 people [21]. Numerous heartbreaking cases have been reported among the deceased. For example, one account describes how a couple's anticipated new life together ended in tragedy during their honeymoon and gained national attention through JTBC (JoongAng Tongyang Broadcasting Company)'s Newsroom [22]. Seoneul, the bride's sister, was unable to say even a simple goodbye to her sister Hwisu, illustrating the intense grief that frequently follows such a profound loss. As this collective mourning unfolded nationwide, researchers began to investigate a central question regarding the impact of technology on tragic cases in the aftermath of loss:

RQ: Can immersive extended reality technology aid in the recovery of bereaved families facing irreversible loss?

## Background

### Gestalt Therapy

Gestalt therapy is one of the psychotherapeutic approaches that uses imagery-based therapy, such as 'empty chair' and 'two chair' techniques. This treatment in psychological counseling allows clients to reconstruct the situation and unite their inner selves by releasing unresolved emotions or unfinished business. In the empty chair technique, the therapist guides the client to imagine the interlocutor representing a deceased loved one, a conflicted person, and the client's own younger self, sitting in an empty chair. Gestalt therapy emphasizes the "here-and-now" experience [19]. Instead of focusing on the interpretation or analysis of past events, it prioritizes how these memories are experienced in the present. Specifically, clients are encouraged to observe their emotions, physical responses, and thought processes as they recall past events within the current context.

SITH was developed based on the principles of Gestalt therapy. In this approach, the client wears an HMD and interacts with a VTA that complements Seoneul's imagination. To satisfy the real-time

intervention requirements, the authors developed a SITH.XRaedo setting and created a vividly visualized VTA streamed to an HMD, manipulated via a PC interface for Seoneul’s grief care

### Cognitive Mechanism of IVR

In HCI, user behavior is often modeled as a perception–cognition–action process in which multisensory information is integrated to support decision making during interaction [23]. Multisensory modalities, including visual, auditory, haptic, and bodily cues, provide information about the physical environment, which is integrated to support rapid reactions. From an information-processing perspective, users interpret sensory input and generate immediate responses based on the perceived state of the interface. User’s interaction therefore involves a continuous loop in which system feedback affects subsequent user reactions. Rather than executing preplanned actions, users dynamically adjust their responses according to changes in sensory information during interaction.

There are cognitive limitations to imagery-based therapy in psychology, despite the need for stable mental representation, sustained attention to the interlocutor, and emotional regulation during the client’s memory recall [24]. Using a VTA, the client can maintain a stable imagined interlocutor long enough to continue therapeutic dialogue, enabling them to overcome the cognitive load of vivid mental imagery, given the dominance of visual sensory in perceptual processing [25]. Thus, the impact of the visual interlocutor’s response to the user’s dialogue, similar to communication in the real world, can elicit a sense of plausibility, helping regulate cognitive processes in the virtual environment where the user thinks, “I am here with the interlocutor now.”

### Presence Mechanism of IVR

Presence, a key psychological effect of IVR, refers to the user’s sense of being located in and interacting with a mediated environment through sensorimotor contingencies. Slater conceptualized virtual experience as three illusions; place illusion, body illusion and plausibility illusion achieved from sensorimotor contingencies [26]. Biocca distinguished physical, social, and self-presence, and framed social presence as the mental model of others in mediated interaction [27]. Their perspectives are complementary regarding the emerging user’s sense of presence and explain how to enhance the cognitive impact of applications using IPT. The commonality between the two perspectives results from cognition derived from perceptual information. Previous studies have identified motor-sensory interaction and spatial immersion as key drivers of presence, while social presence encompasses co-presence, psychological involvement, and behavioral engagement with virtual entities, avatars, virtual humans, and agents. Across definitions, the concepts of “being-there” and “being-there-with” are widely recognized as representative of presence [28], [29]. These are the overlapping points in the presence of IVR with Gestalt therapy, which represent “here-and-now” based on the concepts of space and time.

We hypothesized that the aforementioned cognitive and presence mechanisms provide clues for technological innovation in imagery-based therapy techniques such as Gestalt therapy, and we investigated whether this can actually heal the inner self of humans and influence emotions.

### Methodology

The present study is a single case study, aiming to explore an interdisciplinary project. This study was conducted by

implementing novel technologies that create an immersive, AI-powered VTA. The staff of JTBC who interviewed Seoneul six months after the incident were responsible for arranging the XR-based mourning ritual, courtesy of VHEX Lab.

### Participant Context

The Jeju Air plane crash at Muan Airport claimed 179 lives, leaving many families coping with unexpected loss. Each victim was a cherished family member—someone’s parent, sibling, or spouse. The suddenness intensifies their families’ grief, and many continue to struggle with depression, guilt, and PTSD, sometimes resulting in complex grief disorder after six months.

Among the victims was Hwisu, who died with her husband while returning from their honeymoon, never having entered their new home. Her older sister, Seonul, spent months grieving, recalling fond memories of the wedding day, highlighting the lasting pain the crash caused families. Seonul decided to try the latest technology that might give her a chance to reunite with her younger sister.

### Instrument

The SITH user interface, designed for desktop use, consists of three panels: a live stream of the HMD view, the control panels for the avatar’s preset verbal and non-verbal expressions, and a text field for researcher-authored prompts that enable real-time intervention representing in Figure 1. In therapeutic contexts, SITH creates a triadic structure where the avatar mediates between the HMD-wearing client and the researcher, who orchestrates the XR-based ritual.

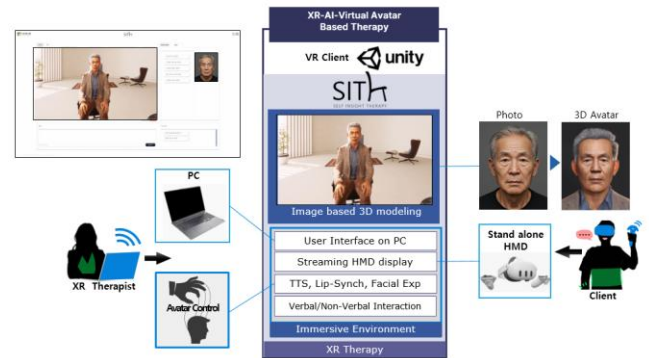


Figure 1. SITH’s conceptual structure

The session unfolds in a virtual Han River park that recreates the sisters’ memorial spot. SITH is a cross-device control application built with Unity Engine 6.0. Preset behaviors are powered by a digital-human rig with facial expression controls and motion-capture–derived animations. Our 3D artists and VR client developers implemented aggressive optimization to minimize latency while preserving visual fidelity, drawing on extensive in-house expertise. The diagram below presents the SITH v1.0 architecture.

We created an authentic, photograph-derived avatar of Hwisu using images provided in advance by Seoneul. The VTA of the deceased was created using VHEX Lab’s in-house pipeline. The process started with a single, front-facing photo of the subject with no facial shadows. Next, Reallusion’s Headshot plug-in was used with the Blender 3D modeling tool. The model was then integrated into the Unity Engine for real-time interactive software development. For verbal interaction, Eleven Labs’ text-to-speech (TTS) solution

and voice cloning were applied. Finally, blend shaping was used for facial expressions and lip synchronization.

### Procedure of XR mourning ritual

Two large displays and two desktop PCs were used for the XR base mourning ritual. One display was for the JTBC camera shoot, and the other was for the researcher. HMD was connected to the PC, not in standalone mode, for procedural stability. Seoneul and the researcher sat face-to-face. After informed consent was obtained, the researcher built rapport and recommended that Seoneul picture a moving image of Hwisu for preventing the risk of overflow and speak with her voice, saying everything she wished to say. During the session, the researcher controlled the avatar's preset reactions and inputs for the VTA's speech on behalf of Hwisu. Seoneul then donned a Meta Quest 3 and completed a brief breathing exercise. In the Han River park scene, she first saw the back of Hwisu's avatar in a white wedding dress, which reminded her of the couple's wedding photo shoot, which was the happiest memory. In the post-interview after the session was conducted.

The researcher performed the session, observing the Seoneul's emotional changes and behavior during each triggering interaction. The interaction trigger process consists of the following stages:

- Partial exposure
- Full exposure
- Empathic response to address the Soeneul's unresolved emotions
- Facilitation of a positive response or role transition to achieve emotional closure
- Accommodate the other's expectations
- Commitment to future reunion
- Final farewell

The overall procedure includes the following steps:

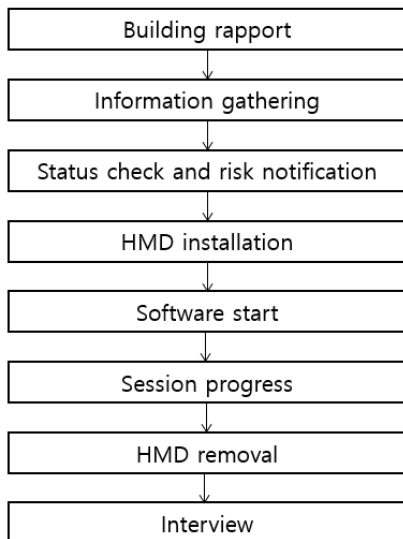


Figure 2. The overall procedure of XR based ritual

### Result

In the XR-based mourning ritual, Seoneul expressed her grief over Hwisu's absence, delivered messages from her family and

friends, and shared what's new in their community, as if Hwisu could hear and understand. Seoneul handed a bouquet to Hwisu's avatar so Hwisu could be happy. Even though Seoneul treated Hwisu's avatar as her sister, she could have distinguished that her sister had passed away in the real world.

Table 1: Procedure of SITH.XRaedo in the sample session

Trigger of Interaction via researcher	Participant's Action
Back of Hwisu in her wedding dress	Surprised and call <b>Her</b> name sobbing
Hwisu turning back	Make a short scream Ask <b>Her</b> condition
Nodding and making Seoneul comfort	Talk about family, friends, <b>Her</b> dog Express her grief
Talking to Seoneul about what she wanted to hear	Surprised and relived Calm
(researcher's voice) Say good bye to her to say hello someday when they meet again	Express how much she loves <b>Her</b> Waive and say good bye to <b>Her</b>

Seoneul exhibited a noticeable emotional reaction upon exposure to the avatar during the session. The researcher instructed her that calling her deceased sister's name would prompt the avatar to turn around; She called her sister without hesitation, initiating their first exchange. The ritual took 20 minutes. System logs are saved in the local computer,

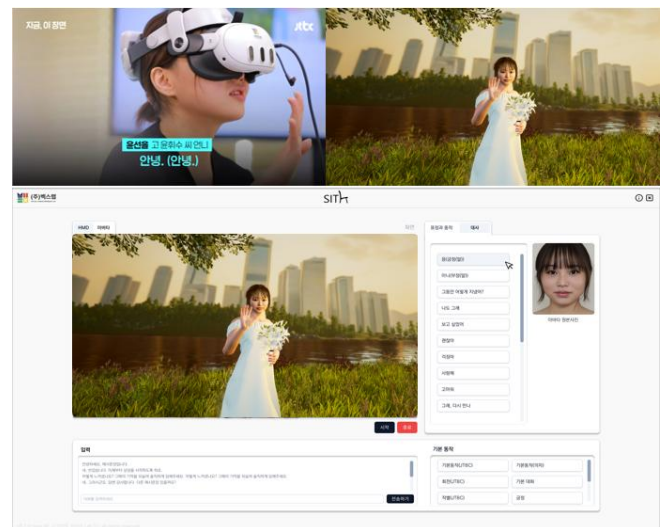


Figure 3. Screen captures of the broadcasting ritual and the interface of SITH.XRaedo

Seoneul valued her experience even though it was just an illusion. She could smile while she sobbed, her heart broken by the

farewell to her sister in the post-interview. We have tracked her emotional status afterwards. In Table 2, the collected reports show progressive her recovery from the deep sorrow.

**Table 2: The emotion status according to the timeline**

Timeline	Participant's Emotion Status
Before SITH.XRaedo (May 2025)	<ul style="list-style-type: none"> <li>- Feels like her sister is still alive and traveling around</li> <li>- Cannot say "good bye" to her sister</li> </ul>
During SITH.XRaedo (May 2025)	<ul style="list-style-type: none"> <li>- Calling her sister's name immediately</li> <li>- Engages in sustained dialogue</li> <li>- Experiences emotional release</li> </ul>
Post SITH.XRaedo (May 2025)	<ul style="list-style-type: none"> <li>- Reports having expressed all the messages she intended to convey to her sister</li> <li>- Values the experience, despite interacting with a virtual avatar</li> <li>- Says a final goodbye with the hope of meeting again someday</li> </ul>
Follow-up I (June 25, 2025)	<ul style="list-style-type: none"> <li>- Still has lingering sleep issues</li> <li>- Feel better overall and occasionally wants to replay the recorded video</li> <li>- Introduces the session to a family</li> </ul>
Follow-up II (July 24, 2025)	<ul style="list-style-type: none"> <li>- Reports increased energy and improved sleep quality, attributing changes to the memorial ritual</li> </ul>

## Discussion

The 'Law of Closure' in Gestalt theory describes a visual association process that connects elements and objects to geometric models perceived visually or to semantic relationships, thereby overcoming interference or incompleteness [30]. In the empty-chair technique of Gestalt therapy, clients fill the empty space with inference and imagination. In this study, Seoneul identified similarities between the VTA and Hwisu's image based on her memory. Despite the ambiguity present in her photos of Hwisu and the differentiation of the third-person perspective, she did not assert that the VTA failed to resemble her sister. Instead, she remarked, "Hwisu, you lost some weight." She was able to engage in a natural conversation, in contrast to her previous admission that she could not speak freely when visiting the charnel house where her deceased sister rests. The system effectively visualized the interlocutor's response to each her utterance. Once she accepted the avatar as her sister, both presence and social presence were established in the virtual environment. Furthermore, the conversation between her and the VTA focused on the present rather than the past. The phenomenon of 'here-and-now,' a core strategy of Gestalt therapy [19], was validated within the XR-based mourning ritual. The cognitive acceptability of the symbolic representation facilitated a sense of reunion, making the experience subjectively real for her, as intended by the plausibility illusion of IVR [26]. The virtual avatar served as a medium for the researcher's real-time intervention, keeping the 'human-in-the-loop' effectively. The sense of emptiness

between the sisters was addressed during the session, enabling her to say "goodbye" to her sister and anticipate another "hi" in the future.

## Conclusion

SITH draws upon the Gestalt principle of imagery, which addresses perceptual gaps by engaging the client's inferences and imagination. This approach bridges the divide between empty space and objects that cannot exist by employing visualized representations. Additionally, the symbolic representation does not serve as a resurrection or extension of the deceased's life. Instead, it constitutes the present presence of the deceased, empathizing with the client's expressions and offering reassurance that the deceased's suffering has ended. Notably, with the integration of this technology and human connection, there have been no reported instances of the uncanny valley effect arising from computer-generated VTAs.

A primary limitation of this study is its single-case design. Although additional cases exist, their findings have not been disclosed. Further studies with larger samples are necessary to clarify and substantiate how technology may facilitate cognitive and presence effects in alleviating the loss and sadness experienced by bereaved families. Another limitation is the absence of a medical diagnosis assessing the participant's physical and mental status. Such assessments should be conducted using vital logs informed by clinical evaluation. Future research will examine the ethical implications of vision technology involving the deceased and its impact on bereaved families' healing experiences.

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