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Master's Thesis
Academic Year 2025

Robot Avatars in Therapy Communication: Lowering Barriers and Enhancing Self-expression for Individuals with Body Dysmorphia

Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2025

Robot Avatars in Therapy Communication: Lowering Barriers and Enhancing Self-expression for Individuals with Body Dysmorphia

Category: Design

Summary

Body dysmorphia and related conditions, such as eating disorders, are complex psychiatric challenges marked by distorted body image, heightened self-consciousness, and barriers to therapeutic engagement. This thesis investigates the use of physical avatar robots to reduce appearance-related anxiety and facilitate emotional expression in therapy. Two user studies were conducted, in which participants operated OriHime avatar robots from individual classrooms to engage in shared therapeutic sessions. All avatars were co-located in a custom-designed OriHime room, enabling group interaction without direct visual exposure. This mediated environment minimized opportunities for visual self-comparison while maintaining a sense of co-presence. Findings indicate that participants experienced reduced nervousness and greater fluency in self-expression when communicating through the avatar. The robot's expressive gestures and standardized appearance contributed to a perceived sense of emotional safety and social equality. Participants described the system as accessible, intuitive, and enjoyable to use. These results highlight the potential of robot-mediated interaction to lower participation barriers and support more inclusive therapeutic environments for individuals with body image concerns.

Keywords:

Human-Robot Interaction; Avatar Robots; Body Image; Eating Disorders; Remote Embodiment; Assistive Communication

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Chapter 1
Introduction

1.1. Eating Disorders

More than three million lives are lost yearly due to eating disorders [1]. As defined by the National Eating Disorders Association (NEDA), eating disorders are serious but treatable mental and physical illnesses that can affect people of any age, gender, background, or body type [2]. Often involving a preoccupation with food, body weight, and a fixation on weight loss, these conditions manifest regardless of an individual's actual body size. Key characteristics can include distorted cognitions, such as body image self-discrepancy [3]. Commonly recognized types of eating disorders include anorexia nervosa, bulimia nervosa, and other specified feeding or eating disorders (OSFED). Anorexia nervosa is characterized by weight loss, difficulties in maintaining an appropriate body weight for height, age, stature, and a distorted body image. Bulimia nervosa involves a cycle of bingeing episodes followed by compensatory behaviors, such as self-induced vomiting, to counteract the effects of the binge eating. Binge-eating disorder or OSFED applies to individuals who experience recurrent episodes of consuming larger amounts of food in a discrete period of time than most people would, and OSFED specifically encompasses individuals who do not meet the strict diagnostic criteria for anorexia, bulimia, or binge eating disorder but still present with a significant eating disorder [2].

The prevalence of disordered eating behaviors has seen an increase, particularly among youth, influenced by social and environmental factors. Japan has the highest prevalence of eating disorders in Asia, yet many individuals with suspected eating disorders do not receive any medical consultation or treatment [4] . Particularly, the COVID-19 pandemic has been linked to an increase in eating disorder cases, with reports indicating a significant rise in cases among adolescents during

this time period [5]. Studies exploring factors such as social media use among college students in Japan and China suggest a link between lower body esteem and more eating disorder tendencies in Japan [6]. Furthermore, research indicates that targeted weight-loss advertisements can unfavorably modify behavior, prompting healthy students who perceive themselves as overweight to frequently diet [7]. Eating disorders also frequently manifest in virtual spaces, requiring special attention to the specific language and tactics used online [8]. Clinically, managing eating disorders presents substantial challenges. Pediatricians in Japan frequently report difficulties in providing psychotherapy and finding referral sources. Managing symptoms such as overeating and anorexia, diagnosing co-occurring psychiatric conditions, and offering parental support also remain difficult. The lack of specialized inpatient facilities and collaborative systems contribute to challenges in providing comprehensive care, leading to overcrowding in child and adolescent psychiatric wards [5]. Given these complexities and the impact on individuals with body image issues, exploring novel approaches to therapy that can address these challenges and enhance the therapeutic experience is crucial.

1.2. Avatar Robots

Robotic telepresence technologies, commonly known as avatar robots, have emerged as a way to enable individuals to participate in social and physical environments remotely. These systems are designed to approximate the experience of face-to-face interaction by combining real-time communication tools with a physical body capable of expressing human gestures and movements. Through this setup, users can convey social cues such as facial orientation, vocal tone, and body language, which are elements often lost in standard remote communication, such as video calls [9, 10].

Unlike traditional videoconferencing platforms, avatar robots offer a form of embodied presence that allows users to occupy space in a room, move around, and engage in dynamic interactions with others. This sense of physical co-presence can increase social inclusion for individuals who are unable to attend events, work, or participate in everyday interactions due to illness, disability, or anxiety. In many cases, the presence of a physical surrogate enhances the perceived legitimacy of the

remote participant and fosters more natural, spontaneous communication among all participants [10, 11].

Recent developments in avatar robot technologies have emphasized customizable embodiment and user-controlled mobility, allowing individuals to express identity through movement, voice, and positioning. These qualities make avatar robots particularly relevant in therapeutic or socially sensitive contexts, where psychological safety and controlled exposure are crucial [9,10,12]. As such, avatar robots are not merely technical tools but are increasingly being explored as relational and emotional interfaces that shape how people connect, express themselves, and feel seen in spaces they might otherwise avoid.

1.3. Motivation

My earliest memories as a child are filled with being misjudged. Since I was four years old, people have looked at my appearance and assumed who I was. Instead of basing their judgment on anything I said or did, they purely based it on how I came across physically. "You look too scrawny and weak." "You don't seem capable at all." "You must be this, you must be that." Comments like these followed me throughout my life, echoing into adulthood. I became painfully aware of the disconnect between how others saw me and how I saw myself in the mirror. Over time, the gap deepened and began to shape and actively distort my sense of identity and my entire personality. I developed severe body dysmorphia, and a constant undercurrent of anxiety that still affects me to this day.

My cultural background also shaped my understanding of body image. My mother is Korean, so from a young age I was surrounded by Korean ideals of beauty, discipline, and appearance. Although I do not personally have an active eating disorder, I have long observed how normalized disordered eating is in South Korea. Being underweight is considered ideal. Dieting is viewed as self-control, and compliments are often reserved for those who are thin. It is not at all unusual for elementary and middle schoolers to receive cosmetic surgery as a gift or as a reward for academic achievement. Relatives frequently compliment children based on how slim they appear, reinforcing values from an early age.

At the same time, I grew up in the United States, where I received very different

messages. In America, I was often "skinny-shamed," treated as weak or fragile because of my size. I could not gain weight easily, and no matter where I was, I felt that my body was being used to define my capabilities. I never fit into either standard. I was too much or too little, depending on who was looking.

These experiences became the foundation for my interest in body image and mental health. I have always wanted to explore the psychological distress that can arise when people are forced to live inside bodies that the world constantly misreads. I aimed for my master's research to focus on body dysmorphia and anxiety, and on how mental distress can translate into physical suffering. That has been my own experience, and it is one I continue to manage every day.

Through my professors from the Embodied Media Lab, I had the opportunity to be introduced to the COI-NEXT project. The COI-NEXT project is a research initiative focused on creating future healthcare and fostering social inclusion. It is funded by the Japan Science and Technology Agency (JST) and brings together universities, hospitals, clinicians, engineers, and designers to co-develop solutions that address real challenges in society [13].

As part of this effort, the project enabled co-design of therapy sessions with medical staff at Yokohama City University and real-world clinical use of the OriHime avatar robot system. The collaboration included partners from Keio University, YCU, and technology developers, and it emphasized working directly with healthcare professionals to design systems that are not only functional but also effective in practice. I was able to contribute to these efforts through my research, which focused on developing interventions that reduce appearance-related anxiety and improve emotional expression in therapeutic settings. My goal has always been to help patients who experience the same, or even more severe, struggles than those of my own. The COI project gave me the space to channel deeply personal experiences into something that could make a difference.

1.4. Research Questions and Contribution

The following is the main research question that guided the main portion of the work.

- **How does the use of physical avatar robots enhance the thera-**

peutic experience and outcomes for participants with body image issues, specifically eating disorders?

To address this, the study explores three sub-questions:

- How do avatar robots help reduce anxieties related to physical appearance?
- What are the comparative differences in self-reported levels of comfort and participation?
- How do avatar robots affect self-identity in group therapy sessions?

The contributions of this research include:

- The design and deployment of a custom avatar robot therapy system using OriHime, in collaboration with clinical staff from Yokohama City University Hospital.
- An user study involving participants diagnosed with eating disorders, incorporating observational data, interviews, and clinician insights.
- An evaluation of how physical avatar embodiment influences patient communication, emotional safety, self-expression, and group dynamics within a therapeutic context.

1.5. Thesis Structure

This thesis is organized into six chapters as follows:

- **Chapter 1: Introduction** This chapter provides an overview of the background and motivation behind the research. It defines eating disorders, discusses the emotional and cognitive challenges they present, and highlights the significance of appearance-related anxiety in therapy. The use of physical avatar robots is introduced as a novel intervention. The chapter concludes with a summary of key contributions and the structure of the thesis.

- **Chapter 2: Literature Review** The second chapter provides an overview of relevant literature, including research on body image, group therapy for eating disorders, and technological interventions. This chapter identifies research gaps that inform the direction of the study.

- **Chapter 3: System and Study Design** This chapter outlines the technical and spatial setup used in the user study. It describes the OriHime avatar robot, the collaboration process with hospital therapists, and the custom-designed system including gesture controls and speaker identification features. The chapter explains how the study environment was configured and how participants interacted with the system during therapy sessions.

- **Chapter 4: Proof of Concept** The fourth chapter presents the user studies' methodology and findings. It covers participant recruitment, session procedures, and data collection methods, including interviews and questionnaires. Key results are discussed.

- **Chapter 5: Results** Presents key findings from the study, including feedback from patients and therapists. Explores how the OriHime system influenced communication, emotional comfort, and the perception of self.

- **Chapter 6: Discussion** Interprets the results in the context of prior literature and reflects on the broader implications for robot-mediated therapy. Considers how the findings relate to reducing appearance-based barriers and informs future system design.

- **Chapter 7: Conclusion** Finally, this chapter provides a summary of the research and highlights its contributions.

Chapter 2
Literature Review

The literature review is structured into three main sections: *body image and self-perception in eating disorders*, *group therapy as a treatment approach*, and *avatar robots and remote embodied communication*. The first section examines how distorted body image, internalized ideals, and sociocultural influences contribute to the development of eating disorders. It considers how these issues manifest within the Japanese cultural context, where underdiagnosis and stigma remain challenges. The second section focuses on group therapy for eating disorders, outlining its benefits, such as peer support and shared experiences. However, it also acknowledges significant obstacles that hinder participation, including anxiety triggered by appearance and self-perception. The third section reviews literature on avatar robots and remote embodiment. It highlights how physical avatars can support emotional expression, reduce social pressure, and increase accessibility in therapeutic settings. These areas provide a foundation for understanding how physical avatar robots can play a role in reshaping the therapeutic experience for individuals with body image concerns, particularly in settings where social comparison and visibility are barriers to engagement.

2.1. Body Image, Self-Perception, and Eating Disorders

The following section explores body image, self-perception, and eating disorders, which are three aspects that are deeply intertwined. Body dissatisfaction serves as a leading predictor of disordered eating behaviors among all ages, from adolescents to adults. Dissatisfaction stems from an individual's persistent negative thoughts about their body and physical appearance.

2.1.1 Distorted Cognition and Body Image Discrepancy

Individuals with eating disorders often experience a significant mismatch between how they perceive their bodies and their actual physical form. The gap between perceived and actual body image reflects not only dissatisfaction with appearance but also deeper patterns of thought that influence emotion and behavior [3,14]. In a study of Japanese junior high school students, it was discovered that body image self-discrepancy was significantly associated with being female, adherence to calorie-restricted diets, and symptoms of psychological distress such as depression and anxiety [3]. The study also found that self-discrepancy scores were higher among students with greater concern for others' evaluations of their appearance, indicating a strong influence of social comparison. Self-discrepancy was associated with lower subjective well-being even in students whose BMI was within the normal range, emphasizing the role of perception over objective body size. Students who expressed a desire to become thinner also showed significantly higher self-discrepancy scores, regardless of their actual weight, and were more likely to interpret their bodies negatively and engage in emotion-driven, appearance-focused rumination [3]. These patterns emerge early in adolescence and reflect how body image distortion ties to internal psychological states. Addressing these distortions requires an understanding of how individuals perceive and emotionally relate to their bodies across social and cultural contexts.

Virtual embodiment technologies are increasingly explored as interventions for body image disturbances. Giuseppe Riva [15] introduces a framework that positions immersive virtual reality (VR) as a tool for altering the internal body representation in individuals with body image disturbances. Drawing on principles of multisensory integration, the study proposes that synchronized visuo-tactile or visuo-motor feedback, aligned with a first-person perspective of a digitally altered avatar, can produce a temporary sense of body ownership. Induced embodiment allows users to experience their bodies differently and potentially disrupt the fixed association between self-concept and physical appearance. These illusions of body transfer may help recalibrate the body schema and provide a therapeutic pathway for individuals struggling with distorted self-perception [15]. Although Riva's study primarily focuses on theoretical foundations, it outlines a plausible direction for integrating immersive technologies into therapy for individuals who may not

respond well to traditional therapeutic systems.

Furthermore, Keizer et al. [16] examine the effects of body ownership illusions in virtual reality (VR) as a means to influence body satisfaction. In their study, participants embodied avatars with slimmer body types than that of their own, and were exposed to synchronized stimulation to induce a sense of ownership over their virtual body. The study highlights the potential of VR to affect body-related cognition through direct sensory experience rather than relying solely on verbal or cognitive restructuring. Results of the study showed that body dissatisfaction decreased significantly, suggesting that even after short-term exposure, virtual embodiment can still disrupt internalized body standards [16]. The focus on visual self-representation is echoed in a study by Wagensveld et al. [14], in which participants were instructed to create two avatars, one reflecting their current perceived appearance and another representing their ideal. The distance between the two was strongly correlated with reported body dissatisfaction, indicating that visualizing internal discrepancies may support personal reflection [14, 16]. However, intervention was limited to a non-clinical population, and its effects remained at the level of perceptual change, without addressing emotional processing or behavioral outcomes. While the study does demonstrate short-term promise, it does not at all explore how users react and respond once the virtual illusion ends and they go back to viewing their actual bodies. There is a significant risk that such interventions could intensify dissatisfaction or reinforce unrealistic body ideals over time.

Portingale et al. [17] conducted a systematic review of thirty-two studies using virtual embodiment to address body image concerns. The review examined how these systems were built, which populations they targeted, and what kinds of outcomes they measured. Most of the studies focused on adjusting body shape, usually by presenting slimmer avatars to encourage changes in perception. Almost all interventions were designed around Western appearance ideals, with thinness as the main concern. Only one study included participants from a non-Western Asian context. Features that are more commonly linked to body dissatisfaction in East and Southeast Asia, such as facial structure or skin tone, were not considered [17]. Again, most studies were conducted with non-clinical participants and measured only short-term perceptual effects. Emotional factors like shame,

anxiety, or self-worth were rarely addressed, and very few systems were tested in therapeutic settings. The review points to a need for more culturally relevant research that considers how appearance concerns vary across regions and explores how embodiment could be used as part of longer-term interventions.

2.1.2 Sociocultural Pressures and Online Influences

Sociocultural norms reinforced through digital platforms have a profound impact on body image dissatisfaction. Online environments frequently promote unrealistic appearance standards that affect vulnerable users who are already prone to disordered eating [7]. Individuals with eating disorders are forced to face persistent and targeted weight loss advertisements, which reinforce harmful ideals and contribute to a neverending cycle of relapse and psychological distress. In a study by Gak et al. [7], participants described feeling overwhelmed by algorithmically curated ads that prioritized appearance over their well-being. Poor design choices made it more difficult to recover in digital environments structured to exploit personal insecurities for engagement and profit.

Feuston et al. [8] examine how gendered language and body norms within online eating disorder communities frequently alienate people whose identities do not align with traditional expectations. Gender-diverse users navigating these communities encounter exclusion and invalidation due to an overbearing dominance of feminine-coded expressions and assumptions about shared experiences. Posts frequently framed struggles in terms of femininity or used gendered language such as “ladies” and “girl problems,” which made many feel unacknowledged and left out. As a result of feeling unwelcome, these users often felt hesitant to participate in the discussion [8]. The study emphasizes that digital communities must actively include diverse voices to avoid reinforcing narrow definitions of who is allowed to struggle with an eating disorder.

Additionally, Nova et al. [18] analyze how social dynamics on broader online platforms such as Twitter can disrupt recovery. Within eating disorder networks, popular influencers circulate content that appears supportive on the surface, but subtly normalizes disordered behaviors. Rather than encouraging healing, these dynamics promote competitiveness or performance among users [18]. The study highlights how social platforms shape not only what content is visible but also

how individuals engage with their recovery process. The combined insights from these three studies underscore the need to examine how sociocultural pressures and platform design contribute to persistent barriers in addressing body image and mental health.

2.1.3 Diagnostic and Cultural Context in Japan

In Japan, the diagnosis and treatment of eating disorders are shaped by cultural and institutional conditions that limit recognition and access to care. Although many junior high school students report body dissatisfaction and psychological distress, few receive professional mental health support or benefit from structured interventions within school environments [3]. Despite the visibility of disordered eating behaviors, there is no standardized system for screening mental health issues in educational settings [3].

Cultural norms that discourage open discussion of psychological struggles further reduce help-seeking and contribute to delayed identification. Adolescents may internalize distress or fail to recognize their own symptoms due to a broader reluctance to engage with mental health topics [3].

In online communities focused on eating disorders, Japanese users often adopt communication styles that emphasize perseverance while minimizing personal suffering [18]. These patterns reflect social values that prioritize stoicism and emotional control, yet they may also obscure the severity of an individual's condition, making support more difficult to access.

Digital intervention tools present additional challenges. Design choices often reflect Western assumptions about body image, communication, and coping strategies, which do not always translate effectively to the Japanese context [6]. Without cultural adaptation, these tools risk alienating users and failing to address the needs of individuals who are already underrepresented in traditional treatment settings.

2.2. Group Therapy for Eating Disorders

Group therapy is widely used in clinical treatment for eating disorders, offering a space for shared understanding, emotional support, and interpersonal growth.

However, group formats also introduces psychological risks, particularly for individuals who struggle with body image sensitivity and social comparison [19]. This section reviews the benefits and limitations of group therapy, setting the foundation for understanding how avatar-mediated formats, such as the OriHime system, may address these challenges by reshaping the experience of group therapy.

2.2.1 Benefits of Group-Based Therapeutic Modalities

Group-based therapeutic approaches for eating disorders offer unique advantages by fostering a sense of community and mutual understanding. Participants often report that being part of a group with shared experiences helps to normalize their feelings and reduce the sense of isolation they previously felt [8]. The shared emotional landscape provides a validating environment where individuals feel seen and understood, which is particularly valuable for those navigating body image concerns and disordered eating behaviors [19].

In both offline and online group settings, peer-to-peer support plays a critical role in promoting emotional resilience. Community members often exchange coping strategies, affirm each other's progress, and encourage self-acceptance. These interactions can foster a greater sense of empowerment and belonging among participants [18]. Design features in digital therapeutic platforms, such as shared progress tracking and discussion forums, can further enhance these benefits by facilitating social connection and collective reflection [20].

2.2.2 Peer Support and Shared Experience

Peer support within group therapy contexts provides critical emotional and psychological scaffolding for individuals with eating disorders. The shared experience of navigating similar challenges often creates an environment where individuals feel safe disclosing personal struggles, reducing shame and encouraging authenticity [8]. These disclosures normalize difficult emotions and foster solidarity, forming interpersonal bonds that are often absent in individual therapy.

In online and hybrid spaces, peer support retains its value. Users on Japanese social media platforms engaged in eating disorder communities by providing mutual encouragement, sharing recovery strategies, and expressing genuine concern

for one another [18]. Such interactions cultivated a sense of belonging and emotional resilience within the group.

The structure of digital platforms plays a an important role as well. Features such as anonymous forums and peer chat-rooms contribute to increased engagement, particularly among users hesitant to speak in traditional settings [20]. The option to contribute asynchronously allows individuals to connect at their own pace, fostering accessibility for those experiencing social anxiety.

Mobile mental health tools that incorporate peer interaction features enhance feelings of being understood and supported during recovery [20]. Online communities, even those found in risk-prone forums such as pro-ana, referring to pro-anorexia forums, and pro-mia, referring to pro-bulimia forums, have shown to provide users with a form of emotional validation through peer feedback and empathetic responses. Pro-ana forums promote anorexia as a lifestyle choice rather than a mental illness, while pro-mia forums encourage bulimia-related behaviors as acceptable coping mechanisms. These interactions, while embedded in harmful contexts, reflect a strong desire for connection and recognition of distress [21].

2.2.3 Challenges in Group Therapy

While group therapy for eating disorders offers benefits, it also presents significant challenges. Discomfort when discussing sensitive topics in front of peers can arise, especially in early sessions where trust has not yet formed [19]. This initial vulnerability may discourage open communication and hinder engagement with the therapeutic process.

In digital and hybrid spaces, the lines between supportive and harmful content are not always clear. Ambivalence about sharing, driven by fear of misunderstanding or judgement, often prevents full participation even in anonymous support groups [8]. Users navigating these spaces must contend with the risk that their experiences will be dismissed or misread, reinforcing feelings of isolation.

Misalignments between user needs and platform design can exacerbate therapeutic barriers. Some systems fail to accommodate the emotional nuance required in recovery spaces. When digital support systems do not reflect the complex realities of users' experiences, they can unintentionally marginalize or invalidate those they aim to support [22]. Such mismatches may result in disengagement or

emotional harm, especially when design overlooks the lived experiences of people with eating disorders.

Even within communities labeled as pro-recovery, users may encounter content that romanticizes disordered behaviors or subtly reinforces unhealthy norms [18]. These conflicting dynamics complicate recovery by blurring the boundary between encouragement and harm. The presence of such content can introduce emotional friction, particularly for those attempting to replace maladaptive patterns with healthier perspectives.

Additionally, the coexistence of pro-recovery and pro-ana discourses in shared online spaces presents a further challenge. Exposure to triggering material within these environments makes it difficult for participants to trust the group as a safe space for healing [21].

2.3. Avatar Robots and Remote Embodied Communication

Developments in avatar robotics have introduced new forms of mediated presence that allow users to participate in social environments without being physically present. These systems are increasingly used in contexts where direct interaction may be difficult, such as education, employment, or therapy. This section reviews how embodied avatars facilitate emotional expression and identity presentation, with attention to how specific design features shape users' experiences.

2.3.1 Emotional Expression Through Avatars

Embodied avatar systems serve as emotionally expressive conduits for users who might otherwise struggle with direct interpersonal interaction. Avatar robots are capable of supporting a form of social presence that enhances emotional clarity without relying on face-to-face exposure [9]. In interviews with disabled workers operating OriHime avatars in café environments, participants reported feeling emotionally and socially connected through their mediated presence. The robot form allowed them to convey feelings and intentions in ways that felt genuine and reassuring, even in high-pressure settings [9].

The expressiveness of avatars was attributed in part to their repertoire of physical actions, such as bowing and waving. These gestures helped users navigate social interactions with reduced anxiety, enabling smoother and more deliberate emotional exchanges [10]. This effect extended to users with communication apprehension, who found that robotic gestures compensated for moments when verbal articulation was difficult [23].

In hybrid educational settings, students reported feeling less judged when interacting through avatar robots and experiencing more agency over how they presented themselves socially. Compared to face-to-face interactions, the avatar system created a buffer that reduced performance stress while still allowing users to express their thoughts and emotions in a meaningful way [11].

2.3.2 Embodiment, Identity, and Presence

Robotic avatar systems introduce new ways for users to embody themselves in social environments without physical presence, reshaping how identity and interpersonal connection are experienced. Users remotely controlling physical avatars often report a dual sense of presence, feeling both grounded in their physical location and socially situated through the robot's embodiment. This parallel presence contributes to a stronger sense of participation and social identity [9].

Gestural affordances such as waving, bowing, or nodding, supported by systems like OriHime, help users convey emotion and agency during interactions. These subtle behaviors allow for recognition as socially present actors, even when the user is physically absent or unable to speak [10]. Such embodied signals reduce the social distance between users and others in the environment, improving mutual awareness.

In classroom contexts, telepresence robots function as intermediaries that reduce appearance-based pressure and anxiety. Participants have reported feeling more at ease engaging in group activities when operating through a robot, especially when concerned about physical presentation or social stress [11]. The physical representation provided by the robot allows users to manage their exposure while still actively participating in interactions.

Some systems are designed to enhance non-verbal communication. For example, robots that transmit gaze direction or simulate posture shifts have been shown

to increase feelings of involvement, even when users do not verbally contribute. These features help establish an embodied presence and allow users to maintain a connection to the group's shared attention and dynamics [23].

2.3.3 Robot features Affecting Self-perception

The AV1 robot, developed by Norwegian company No Isolation, is a telepresence device designed to help children with long-term illnesses maintain participation in school [24]. AV1 sits on a classroom desk and is controlled remotely by children through a mobile device. The robot transmits audio and video, incorporating subtle features such as head turns and light signals to simulate social presence. In the study, Nordtug and Johannessen examine how these physical characteristics influence the way users perceive themselves and how others perceive them. Students described feeling more socially present and emotionally included when using the AV1, particularly because the robot allowed them to sustain a role in group settings despite physical absence. The robot's physical form influenced users' sense of agency and reinforced their social visibility in ways that shaped their self-perception [24].

Studies by Choi and Kwak [25] and Almeida et al. [26] explore how the movement and responsiveness of telepresence robots shape users' sense of presence, but they do so with different goals and scopes. Choi and Kwak focus on one specific robot-mediated communication system, studying how users felt when they controlled a robot that could perform simple gestures such as turning or nodding. Their study involved users who remotely controlled a robot that could perform simple gestures like turning or nodding. Authors found that when the robot's movements aligned with what the user intended, people felt more expressive and socially acknowledged. But when the timing was off or the robot could not respond properly, users felt a sense of disconnection and were unsure whether others recognized them as individuals. The study also highlights that even when users were controlling the robot, they were not always perceived as being present in the space, especially if others around them did not respond to the robot as if it were a person [25]. Findings suggest that motion fluency, gesture clarity, and how the people in the room interpret the robot all play a role in users' ability to feel seen. Almeida et al. take a broader approach by reviewing a range of existing

telepresence robot systems. Their paper suggests that robots that can simulate human-like behaviors, such as shifting attention or orienting their body in space, tend to improve user engagement. Movement fluency, timing, and gesture variability help users feel more connected and emotionally supported. If the robot is slow or stiff, people tend to lose focus and withdraw from the interaction [26].Unlike Choi and Kwak, who focus on users' internal experience of identity, Almeida et al. center on interaction design and practical use across different settings, including education and healthcare. Both studies point to the same conclusion that when a robot moves in a way that feels intentional and responsive, it becomes easier for users to express themselves, feel seen by others, and stay emotionally involved in the conversation.

Despite studies collectively illustrating how a robot's physical characteristics and movement capabilities influence users, there has been a lack of evaluation and exploration about how robot embodiment influences therapeutic engagement or self-perception in the specific context of eating disorders. Therefore, addressing this gap is crucial for opening new directions for designing avatar systems that are emotionally attuned to the lived experiences of individuals with body image concerns.

2.3.4 Robot-Mediated Therapy and Accessibility

Robot-mediated therapy offers a promising approach to improving accessibility for individuals who face appearance-based or physical barriers in traditional therapeutic contexts. Telepresence robots can support real-time participation without requiring physical presence, allowing users to maintain social connection and agency. In hybrid learning environments, these robots enabled students to attend class, move within the space, and interact with others, which fostered a stronger sense of inclusion and involvement [11].

Avatar robots also serve as expressive tools that allow users to communicate identity and emotion despite physical limitations. Individuals with disabilities reported feeling as though they were "shining" through the robot, describing it as a way to express their personality and presence without being limited by their bodies [10]. This type of mediated communication can offer psychological relief and reinforce self-expression, especially in therapeutic settings where appearance-

related anxiety is common.

These forms of mediated embodiment align with broader shifts in how presence is conceptualized in therapeutic design. Virtual and robotic proxies for interaction allow people to connect and engage without exposing their physical appearance. This transition from visible flesh to abstract proxies of interaction represents a shift in how social presence is constructed, opening up new opportunities for inclusive therapy [12].

Recent developments in parallel embodiment systems further extend this potential. Research has shown that users operating multiple robotic avatars simultaneously could participate in distinct tasks across different contexts, reporting increased agency and productivity. Such systems could be adapted for therapy to allow users to alternate between individual reflection and group participation, or to explore multiple roles and identities in a controlled environment [27].

2.4. Summary and Research Gaps

The existing literature reveals a multifaceted understanding of eating disorders, shaped by psychological, sociocultural, and therapeutic dimensions. Cognitive distortions in body perception are well documented, particularly among adolescents, with strong associations between body image dissatisfaction and psychological distress [3]. Cultural norms in Japan surrounding emotional restraint and mental health stigma further complicate early identification and intervention [3, 18]. Although digital interventions have expanded, they often lack inclusivity and adaptability for underrepresented populations [6].

Group therapy is widely recognized for its benefits in providing emotional validation, mutual recognition, and peer-based support [8, 19]. Group-based formats help normalize shared struggles and foster a sense of belonging. However, significant barriers remain, such as discomfort in disclosing sensitive topics, risk of triggering content, and difficulty establishing trust within a group [8, 21]. Online and hybrid group interventions provide greater accessibility through anonymity and asynchronous communication [18, 20], yet they often fall short in enabling embodied participation and authentic identity expression.

Parallel to these developments, research in avatar robotics and remote embodi-

ment demonstrates how mediated presence can enable participation without physical exposure. Telepresence systems have been shown to increase agency and social integration in hybrid environments [11], while robotic avatars support identity reconstruction and psychological safety for users with physical impairments [10]. These systems allow individuals to express themselves beyond the constraints of their bodies, offering new frameworks for self-representation and social engagement [12]. Accessible parallel embodiment also presents emerging possibilities for multitasking and self-directed interaction across multiple environments [27].

Despite these technological and therapeutic advances, several research gaps remain. First, there is a lack of integrated interventions that combine the relational depth of group therapy with the psychological safety and customization enabled by remote avatars. Second, few studies have explored how embodiment technologies might reduce appearance-based anxiety in therapeutic contexts for those with disordered eating or body dysmorphia. Third, most embodiment research has been confined to education or employment settings, leaving its therapeutic potential underexplored.

This thesis addresses these gaps by proposing a novel group therapy model using remotely controlled avatar robots for individuals with eating disorders and body dysmorphia. The system is designed to preserve the interpersonal dynamics of group therapy while minimizing visual exposure, supporting agency, and enhancing emotional expression through avatar-mediated communication. Grounded in interdisciplinary research across HCI, robotics, and clinical psychology, this work aims to demonstrate the viability of robot-mediated therapy as a promising approach for addressing long-standing barriers in mental health support.

Chapter 3
Concept Design

This chapter outlines the OriHime avatar robot system developed for therapy sessions with participants experiencing eating disorders. It introduces the OriHime robot's function and explains the process of designing and setting up the experiment system in collaboration with clinical staff. The section also covers the robot's interaction mechanics and the final environment used during therapy sessions.

3.1. COI-NEXT Collaboration

This study was conducted as part of the "Co-Creation Base for Future Healthcare" project, supported by the Japan Science and Technology Agency (JST) under the COI-NEXT program. The larger initiative aims to create inclusive healthcare models through the development of communication technologies that support long-term well-being and participation [13]. The research presented in this thesis falls under that framework and contributes to ongoing work related to remote therapeutic environments. The project is a collaboration between Keio University, Yokohama City University (YCU), and OryLab Inc. Keio University, through the Graduate School of Media Design (KMD), was responsible for system design, user interaction research, and coordination of the overall study structure. Yokohama City University oversaw all clinical aspects of the research, including ethical review and approval, facilitation of therapy sessions, and clinical supervision. Therapists and psychiatrists affiliated with YCU were directly responsible for recruiting participants, conducting initial screenings, and determining eligibility based on clinical criteria. OryLab Inc., the developer of the OriHime robot, supported the project by providing hardware, technical documentation, and as-

sistance with deployment and system setup.

The study is part of a broader, government-funded project that includes regular collaboration between clinical staff, academic researchers, and industry partners. As such, the system evaluated in this thesis was not developed independently, but emerged from an ongoing co-creation process between these groups.

3.2. OriHime Avatar Robot Overview

As previously noted, avatar robots allow users to express their true selves without being physically seen or present in a room. Telepresence enables a remote individual to experience a sense of presence in different physical locations. Physical robots operated from a distance serve as physical stand-ins for their users.

OriHime is a telepresence robot developed by OryLab, a company established in 2012 with the aim of creating a sense of presence for individuals unable to be physically co-located due to hospitalization, physical disabilities, or geographic distance [28]. Although remotely operated, the system facilitates a shared feeling of presence for both the user and those in the physical space.

There is a diverse range of Orihime models varying in size, appearance and function. For example, the classic OriHime model is a compact desktop robot equipped with a camera, microphone, and speaker. It enables expressive motion functions, such as nodding, waving, shaking its head, appearing shy, and flapping its arms. The OriHime Eye is another system designed specifically for individuals with severe physical limitations, including those who can only move their eyes. It uses an advanced eye-tracking interface to allow users to control the robot and generate speech, enabling communication and participation, requiring minimal physical input. Another system, OriHime-D, is a larger mobile version with more advanced motion capabilities, multiple joints, and detailed mobility functions. This variation allows remote users to perform active roles in physical spaces.

The OriHime has been studied across a range of applied contexts, which supports its reliability and appropriateness as a communication tool. In a hospital school setting, Yamamoto et al. [29] documented how the robot allowed children with chronic illness to maintain social connection with their peers and experience classroom life from a distance. The study emphasized the importance of tai-

loring the robot's appearance and interaction design to fit emotionally sensitive environments [29]. Vikkelsø et al. [30] examined OriHime's use in a rehabilitation program for people with acquired brain injury, highlighting how the robot served as a bridge for social re-entry. Participants used OriHime to observe and gradually engage with community spaces, and therapists noted its value in easing transitions back into group interaction [30]. In a different domain, Yuji Sone [31] analyzed how OriHime has been used in artistic and public performances, framing the robot as a socially affective actor that allows users with disabilities to participate in cultural expression on their own terms. These studies show that OriHime has been used in both clinical and creative settings, confirming its value as a tool for mediated participation and social engagement.

For this study, the classic Orihime model is used. The OriHime is equipped with a camera, microphone, speaker, and movable arms. Its simple-to-use interface allows users to engage in interaction remotely by expressing gestures and engaging in real-time conversation. Standing at just 23 centimeters tall, its compact and friendly design makes it well-suited for therapeutic settings, where creating a comfortable, approachable presence is essential. Its small stature and expressive yet familiar humanlike gestures support natural communication while minimizing participant discomfort.

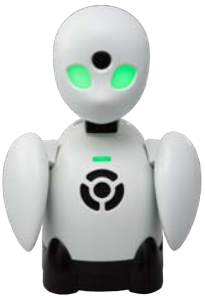

Figure 3.1: Classic OriHime Model.[1]

1 Source: `https://orihime.orylab.com/`

3.3. Custom OriHime System Setup

This section details the customized implementation of the OriHime avatar robot system tailored for the study. The setup process was developed in collaboration with licensed therapists to ensure the environment and interface fit the needs of participants with eating disorders. We describe the iterative design process, including therapists' input on layout, communication constraints, and interaction flow. The final system configuration, including additional interaction components, and integration Arduino-based triggers, is also presented.

3.3.1 Design Process with Therapist

As previously noted, we developed the study's foundational design through direct collaboration with therapists from Yokohama City University Hospital (YCU). The therapist team consisted of three members, Dr.Mio Ishii, Dr.Kenkichi Takase, and Dr.Tamii Nagoshi. Dr.Mio Ishii is our lead psychatrist, and is a clinical psychiatrist, specializing in psychiatric emergency care and adolescent psychiatry. Dr.Kenkichi Takase is a Professor in the Faculty of Letters, and Dr.Tamii Nagoshi is a licensed psychologist, clinical psychologist, school counselor, and psychosomatic medicine counselor.

The first step in the design process involved the creation of the therapy environment, which was discussed and planned during an initial meeting held in September. During this meeting, the physical layout and atmosphere of the therapy space were designed together with the clinicians, with attention to how the environment can support comfort and communication for patients with eating disorders.

This collaborative process also played an important role in determining the inclusion criteria for participant recruitment. Details of participant recruitment and demographics are described in Chapter 4. The decision to focus on this demographic is based on the clinical team's experience with the typical onset and trajectory of the disorder and ethical and practical considerations regarding engagement and communication styles.

Figure 3.2: Initial Orihime Setup Planning

The study's therapy sessions were designed to be carried out by a licensed psychologist using the OriHime avatar. These sessions were intentionally left open-ended and unstructured, with conversation typically beginning with asking participants to reflect on their past week's events. We chose this format in an effort to create a space where participants could express themselves more freely without the pressure of responding to a fixed set of clinical questions.

By involving mental health professionals from the early stages of development and throughout the planning process, we designed a therapy environment and session structure that reflected clinical priorities.

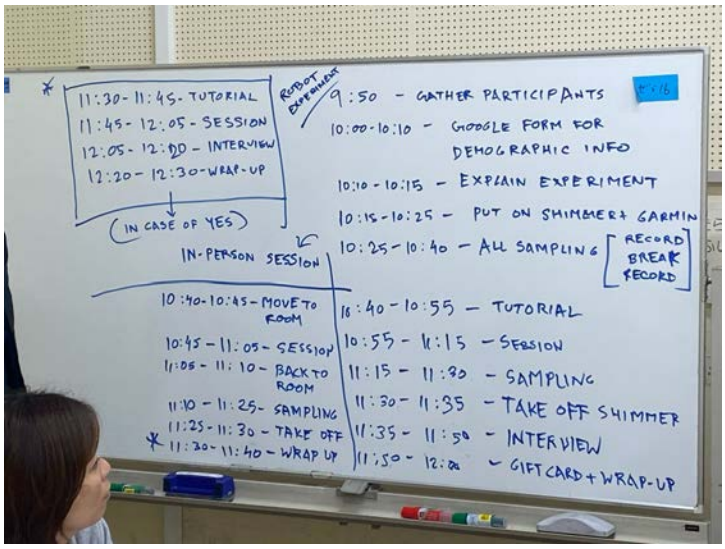

Figure 3.3: Initial Discussion of Schedule with Therapist Team

Figure 3.4: Initial Setup Design

3.3.2 System Setup Overview

We refer to the finalized space designed for avatar-mediated therapy sessions as the OriHime Room. The room is constructed using styrofoam boards layered with wallpaper to create an enclosed yet comfortable environment. Magnets were used to connect the walls, allowing for a lightweight and modular setup. A table is placed at the center between the therapist avatar and the patient avatar to simulate an in-person conversational setting. To promote relaxation, two potted plants are positioned on the side of the room, introducing natural visual cues to evoke a calm feeling. Four window panes are installed, with two placed behind the therapist avatar and two behind the patient, providing spatial balance and a familiar room atmosphere. Outside the OriHime Room, three movable sliding panels are positioned and covered with printed cloth depicting fluffy clouds across an broad blue sky, to enhance the overall sense of openness and tranquility. A direct enhancement developed during the study, is the implementation of a voice distinction system. This addition addressed a recurring difficulty reported by participants in distinguishing which OriHime robot was speaking during group interactions. Initially, the team considered placing an LED strip belt across each OriHime's chest area to indicate speech activity. However, this solution proved impractical, as the belt required frequent removal and reattachment and often slid out of position during use.

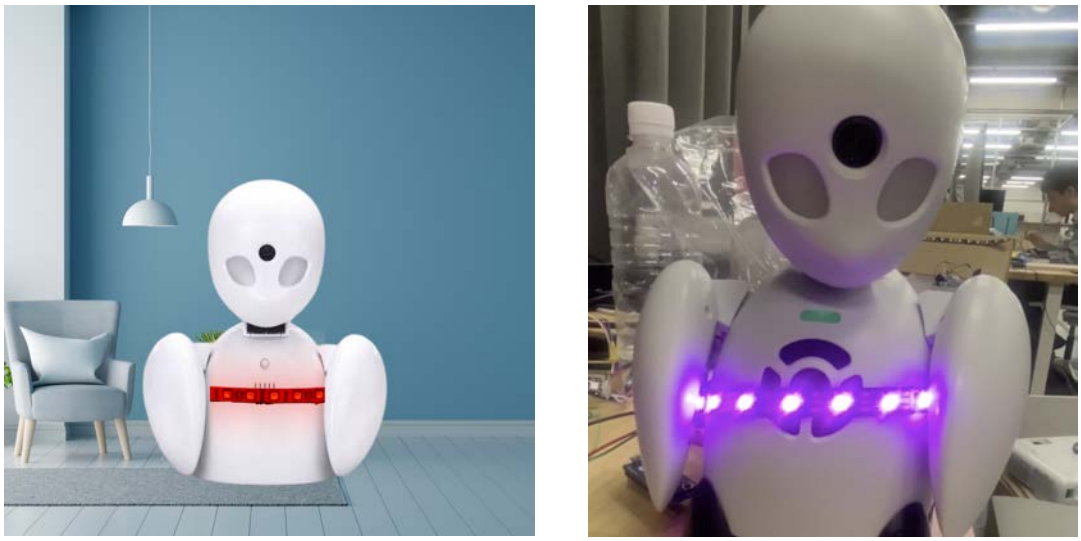

Figure 3.5: Initial Voice Distinguishing System Design

The final voice distinction system was developed using a Microphone Sound Sensor Module (KY-037) connected to an Arduino Uno. A 5V LED strip was integrated with the sensor system to respond to audio input by changing color dynamically. To improve accuracy, voice signals were filtered so that the lights would respond only to the specific OriHime robot currently speaking. Each OriHime was assigned a distinct color to provide a clear visual cue for speech attribution. For example, OriHime 1 displays blue, OriHime 2 pink, OriHime 3 yellow, and OriHime 4 green. This configuration helped participants identify which avatar was speaking more easily and improved the overall interaction experience within the therapeutic setting.

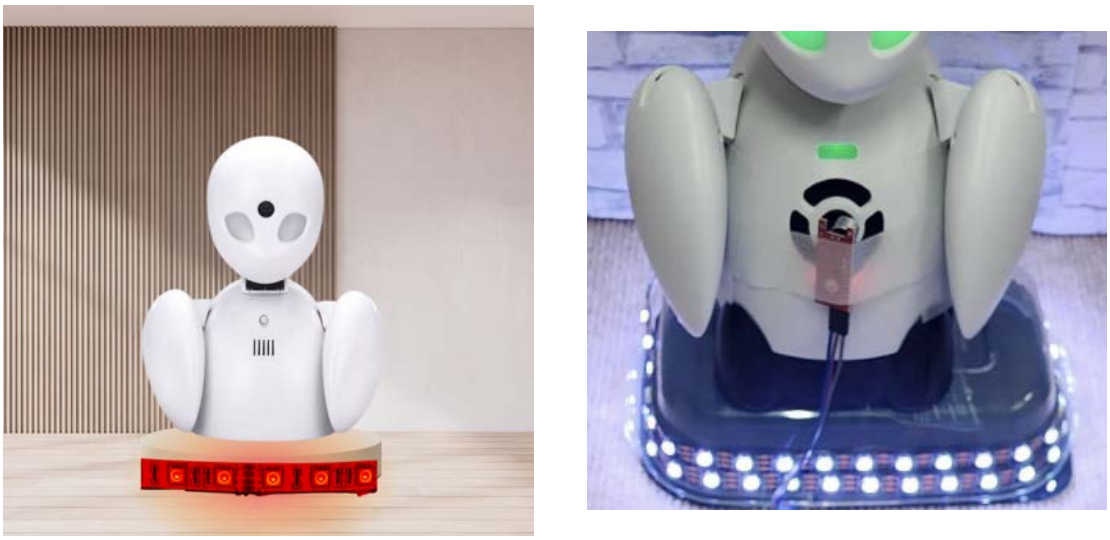

Figure 3.6: Final Voice Distinguishing System Design

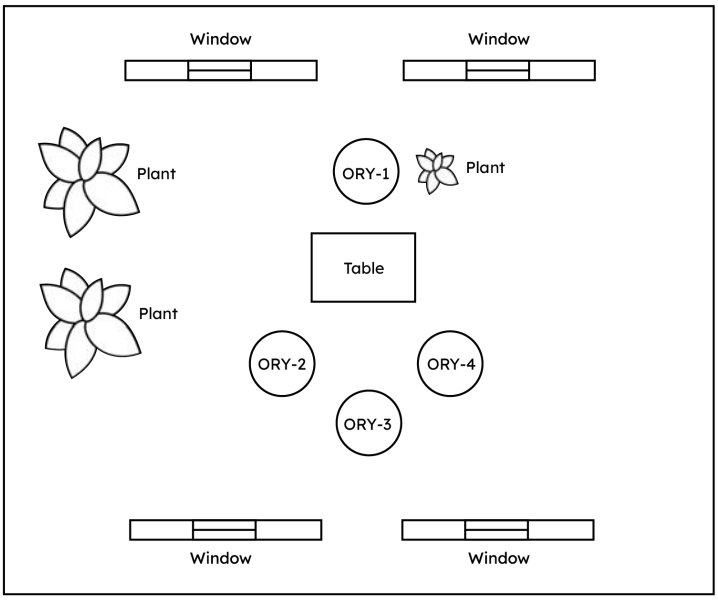

Figure 3.7: Overview Diagram of Orihime Room Setup

Figure 3.8: Orihime Room Setup

3.4. Interaction Mechanics

Given the vulnerability associated with body image concerns and eating disorders, the interaction mechanics of the study carefully structured to prioritize participant's emotional safety. One of the central design decisions involved the physical separation of participants. Participants were escorted one at a time into designated private rooms, ensuring that no participant would see or interact with another in person before, during, or after the session. Physical isolation was implemented with the aim of eliminating opportunities for visual comparison, which may trigger anxiety, self-consciousness, or harmful self-evaluation in individuals affected by disordered eating.

The avoidance of face-to-face peer interaction created a controlled environment where participants could focus on their own experiences without the distraction or pressure of being observed by others. OriHime avatars further supported this goal by serving as mediators of presence and communication. Since participants were not physically co-located, their only form of interaction with others was through avatar robots. This setup reduced the emphasis on visual appearance and allowed

participants to focus more on verbal expression and interpersonal connection. The structure was intended to create a space where participants could speak freely, without the pressure of being physically observed or compared.

3.5. Therapy Session Setup

The therapy sessions were carefully configured to make use of the OriHime system's remote interaction capabilities. Each patient controlled their assigned OriHime robot using a tablet installed with the OriHime application. Through this interface, participants were able to move their OriHime's head, change its gaze direction, and activate gestures, such as waving or nodding, which helped simulate a natural conversational presence.

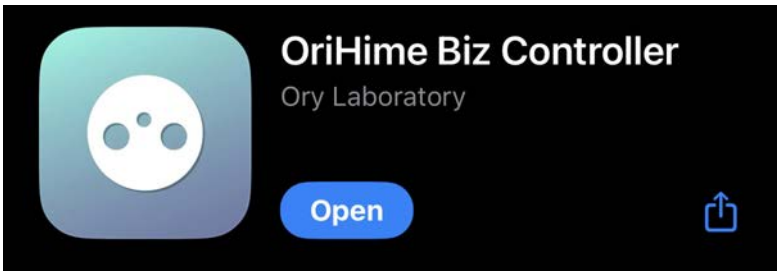

Figure 3.9: Orihime Controller Application

Figure 3.10: Controller App Interface

The general infrastructure of the sessions was distributed across several physical classrooms. A total of four OriHime units were used, one robot assigned to the therapist and the remaining three assigned to the participants. Each OriHime was paired with a designated tablet, and each tablet was placed in a separate classroom (Ex:Rooms 113, 114, and 115) to maintain participant privacy and prevent direct visual contact. The robots were located in one central space called the OriHime room. One separate classroom served as the control headquarters for the research team and technical supervision.To support uninterrupted connectivity, individual routers and pocket Wi-Fi devices were used to ensure stable network performance across all rooms.

Each session followed a consistent structure. The participants were individually brought into their rooms, where they began by logging into the OriHime application on the tablet. Once connected, they operated their OriHime robot to join the session taking place in the main therapy room. The therapist, operating their own OriHime robot, facilitated the conversation from the same central space. All communication occurred through the OriHime system using real-time audio, video, and gesture features. The goal of this setup was to simulate a shared group

environment while preserving the physical separation necessary for participants with appearance-based anxieties.

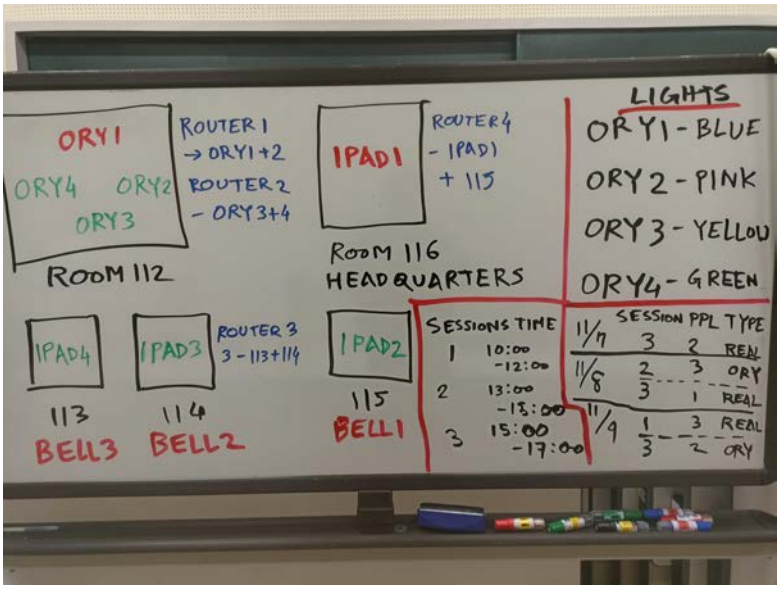

Figure 3.11: First User Study Room Configuration Plan

Chapter 4
Proof of Concept

This chapter presents the methodology and implementation of the user study conducted to explore the feasibility and effects of the OriHime avatar therapy system in practice. Building on the system design described in the previous chapter, this section outlines how the sessions were carried out with participants and clinicians, detailing the recruitment process, study structure, and data collection methods. The chapter is organized to reflect the structure of the study itself, beginning with an overview of participants and recruitment, followed by descriptions of the procedures, interviews, and supporting data collection. These elements provide a foundation for evaluating the therapeutic viability of the system.

4.1. Participants

This study focused on individuals who had been diagnosed with eating disorders and were receiving ongoing psychiatric care at Yokohama City University Hospital. The targeted population consisted of young adults who were expected to benefit from a therapeutic environment that reduced the psychological burden associated with physical appearance and face-to-face interaction.

Inclusion criteria required participants to:

- Being between 16 and 29 years of age,
- Having a clinical diagnosis of an eating disorder (primarily anorexia), and
- Currently attending the psychiatric clinic at YCU.

It is important to note that although the formal inclusion criteria specified a minimum age of 16, one participant aged 15 was also included in the study with consent and by therapist recommendation.

The recruitment process was developed in close collaboration with the hospital's lead psychiatrist and clinical therapy team. The inclusion criteria were finalized during a planning meeting held in September.

Participants who met these conditions were introduced to the study through direct recommendation by their attending psychiatrists. Therapists provided both verbal explanations and written consent forms, following ethical guidelines approved by the institutional review board. Participants were informed that they could choose not to participate or withdraw at any time without affecting their ongoing treatment or care.

The study was conducted in two separate instances to accommodate recruitment requirements and scheduling availability at the hospital. The first instance took place from November 7 to 9, 2024, and the second from April 12 to 13, 2025.

Throughout each session, three OriHime robots were used. One was assigned to a licensed psychologist acting as the therapist, and the remaining two were assigned to participating patients. Each patient was placed in a separate classroom and controlled their OriHime avatar remotely using an iPad installed with the OriHime application. The avatars themselves were located in a shared therapy space called the OriHime Room. This setup allowed the therapist and patients to interact as if they were in the same room, while preserving visual anonymity and physical separation. All sessions followed this structure.

4.2. Methodology

This section outlines the methodological structure of the proof-of-concept study, including data collection procedures, session formats, and evaluation strategies used to assess the impact of robot avatar–mediated therapy compared to traditional in-person therapy sessions. The goal was to examine whether avatar robots could provide a more emotionally accessible and psychologically safe communication experience for individuals with body image distress.

4.2.1 User Study Overview

A single user study was conducted in two separate instances with Yokohama City University Hospital to compare communication behavior and psychologi-

cal response across two therapy modalities: (1) robot-mediated therapy sessions using OriHime avatar robots, and (2) conventional group therapy sessions held in-person. Although conducted at different times, both instances shared a unified system design and evaluation structure. Each participant only took part in one session instance, and there was no overlap between participants. The study was carried out in partnership with the clinical team at the hospital, including attending therapists and a supervising psychiatrist.

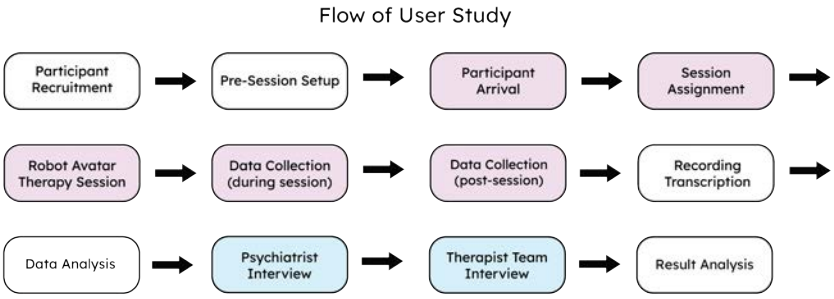

Figure 4.1: Diagram of User Study Process

After each session, participants completed interviews designed to gather qualitative insight into their emotional responses, perceived communication ease, and engagement. Interviews were semi-structured, conducted in Japanese, and later translated into English for analysis. Participants were asked about their experiences using the OriHime system, their emotional state during the session, and whether they felt more or less able to express themselves compared to traditional in-person sessions. These responses formed the basis for much of the subjective evaluation presented in Chapter 5.

4.2.2 Interview with Therapists

In addition to participant feedback, clinical insight was gathered from therapists involved in the sessions. Interviews focused on their observations of patient behavior, perceived changes in verbal participation, and general impressions of the OriHime system's clinical utility. Feedback was also solicited regarding possible system improvements, therapeutic risks, and implementation challenges. Their

responses were used to contextualize participant outcomes and guide design recommendations, detailed in Chapters 5.

4.3. User Study

This section presents how the OriHime therapy system was deployed in practice through two scheduled instances of a single user study conducted in collaboration with Yokohama City University Hospital. The study was designed to evaluate communication behaviors, emotional engagement, and the feasibility of using avatar robots in a clinical group therapy setting. While both instances followed the same core structure, they involved different participants and were carried out during separate periods. The following subsections detail the participant arrangement, room setup, session procedures, and data collection process used to support qualitative and physiological analysis.

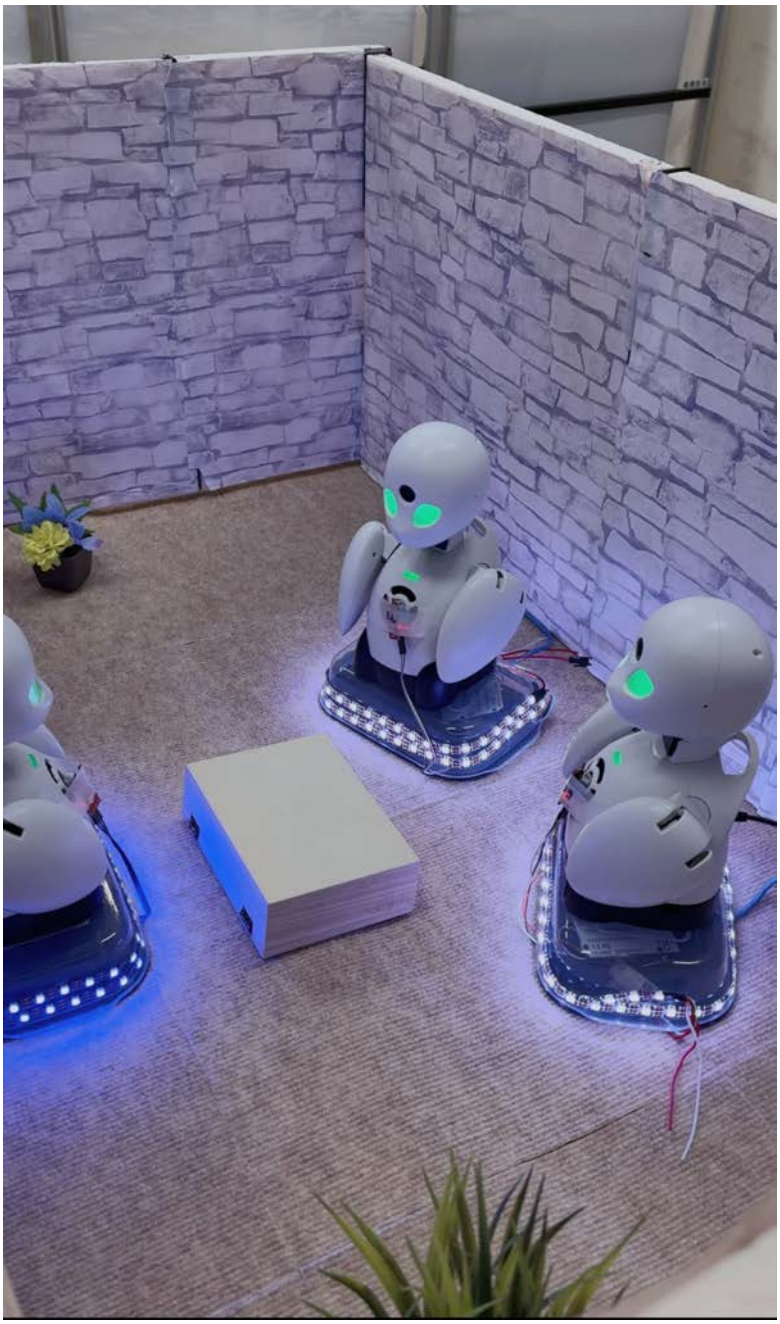

Figure 4.2: User Study Orihime Room Setup

4.3.1 Participants and Setup

The user study was conducted with a unique set of participants, all of whom were recruited through the hospital's psychiatry department. As outlined previously, participants were young adults with a clinical diagnosis of an eating disorder, primarily anorexia nervosa. Each individual was assigned an OriHime avatar and placed in a private room, ensuring that they never saw the other participants in person.

The study was conducted across six sessions, with each session involving one therapist and two to three participants, totaling 12 participants who participated in the OriHime avatar robot sessions analyzed in this study. All participants used nicknames to protect their identities. Among them, ages ranged from 15 to 24, with 11 females and 1 male. As previously noted, although the original inclusion criteria specified an age range of 16 to 29, one 15-year-old participant was included in the study with full clinical approval.

During the study, the therapist used an OriHime robot, positioned centrally in the shared OriHime Room. Communication occurred exclusively through the robots using audio, gesture, and head movement, controlled via tablets. All avatars were positioned around a table within the OriHime Room to simulate a group therapy layout, while maintaining visual anonymity and physical separation. Each tablet was pre-connected and pre-configured to reduce technical friction and ensure that participants could focus entirely on the therapeutic experience.

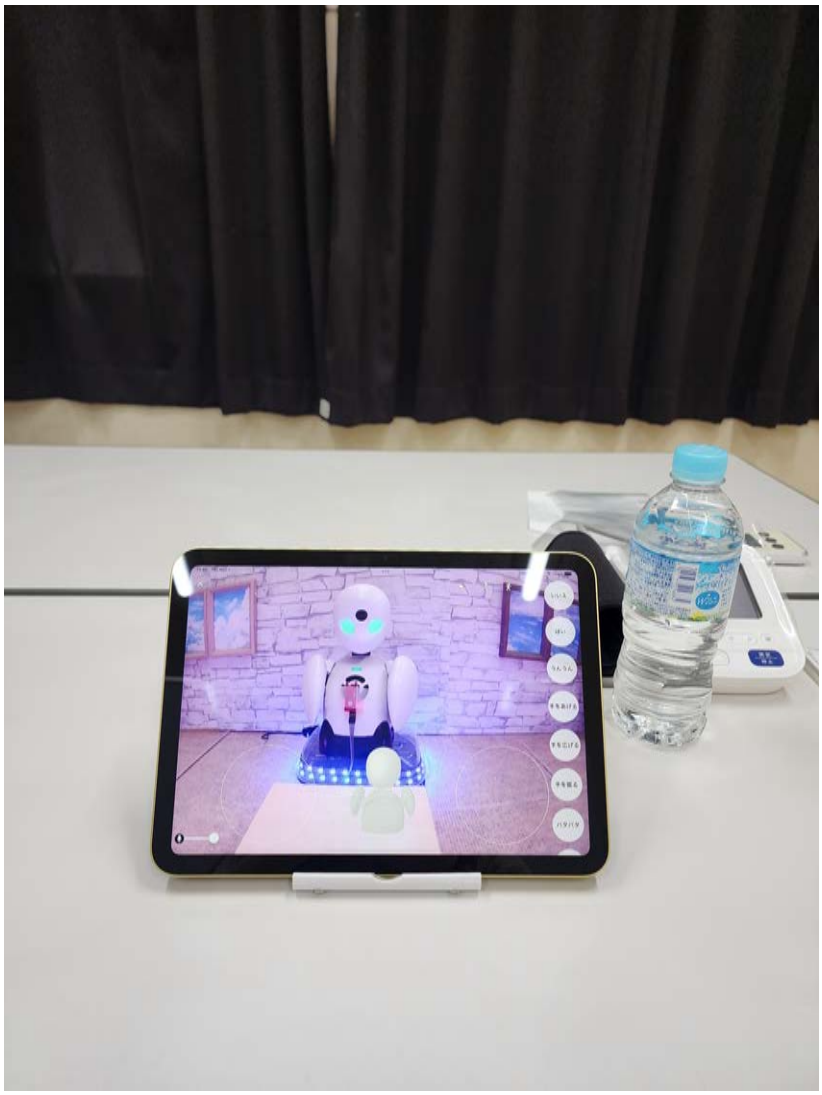

Figure 4.3: Participant View of Tablet During Session

Therapists and researchers coordinated session times, room assignments, and Wi-Fi device checks. Each participant was assigned a designated researcher for onboarding, ensuring that ethical protocols, consent requirements, and emotional safety considerations were consistently upheld.

4.3.2 Procedure and Data Collection

Each session followed a structured yet flexible procedure, beginning with a brief setup period in which participants were introduced to the OriHime system and given time to explore basic controls. This onboarding process lasted approximately 5–10 minutes and was facilitated by a researcher who remained present until the participant signaled readiness. After this, the researcher left the room to preserve privacy, and the therapist began the session by greeting each participant through their OriHime avatar.

The therapist initiated the conversation by inviting participants to reflect on their thoughts or emotional state over the past week. Sessions were semi-structured to allow natural dialogue, and the therapist responded to each participant in turn. No participant was ever required to speak, and silences were treated respectfully. Sessions typically lasted between 30 to 45 minutes.

Data collection occurred on two levels:

- **Subjective feedback** through post-session interviews, which were transcribed and translated from Japanese
- **Clinical observation** gathered through therapist notes and post-session interviews.

All sessions were audio-recorded, with participant permission, for analysis and cross-referencing. To analyze participant responses, I conducted an inductive thematic analysis at the semantic level. Audio recordings from the sessions were transcribed in Japanese and translated line by line into English. I manually coded the English transcripts, identifying repeated patterns and emotionally significant phrases across participant speech. Codes such as “felt safe behind the robot,” “easier to speak without being seen,” “OriHime reflected me,” and “no fear of judgment” were used to capture key aspects of the data. These codes were reviewed through constant comparison and grouped into broader themes. The final four themes are Emotional Safety, Communication and Expression, System Feedback, and Personalization, which are discussed in Chapter 5.

4.4. Summary

This chapter outlined the proof-of-concept implementation of the OriHime-based therapy system, including participant recruitment, session procedure, data collection, and evaluation strategies. Two user studies were conducted at Yokohama City University Hospital, engaging individuals with eating disorders in group therapy sessions mediated through avatar robots.

The methodological design prioritized emotional safety, anonymity, and natural interaction. By separating participants physically and allowing them to interact solely through OriHime avatars, the study created a novel form of therapeutic space tailored to the needs of individuals with body image distress. In addition to qualitative interviews, biometric feedback was collected to provide a preliminary foundation for future multi-modal analysis. The results and insights drawn from this implementation are presented in the following chapter.

Chapter 5
Results

This section presents the findings of the user studies, including evaluations, feedback, and suggestions from participants, collaborating therapists, and the main psychiatrist.

5.1. Participant Evaluation, Feedback, and Suggestions

The result of participant feedback have been categorized into four main categories: Communication flow and expression, emotional comfort and psychological safety, avatar perception, and system feedback. All quotes from audio recordings have been directly translated from Japanese to English. Participants generally perceived robot avatars as a promising avenue for communication, particularly for individuals experiencing social anxiety or discomfort in face-to-face interactions. They consistently noted that the avatars significantly lowered barriers to mental health therapy and expressed positive initial impressions regarding their potential for broader application.

5.1.1 Communication Flow and Expression

Fluidity and clarity of communication in therapy sessions were also reported to be significantly enhanced during robot avatar sessions. The structure of the avatar interface, which allowed for real-time audio exchange and a set of simple gestures, helped users convey their thoughts more freely. Many participants, especially those who usually experience difficulty organizing their thoughts in a group context, expressed that speaking through the avatar made initiating and maintaining

conversation easier. Without the pressure of face-to-face contact, they could stay focused on their ideas and coherently express them.

> *"I didn't hesitate as much. The robot helped me speak more naturally."*

> *"In a normal group, I always overthink my tone, but here I didn't."*

The absence of real-time visual feedback from others was also a major factor in reducing performance anxiety. Some participants described that, in typical face-to-face settings, they often feel overwhelmed by needing to interpret others' expressions or anticipate reactions. OriHime's consistent and limited range of facial expressions removed this burden. The robot's behavior made it easier to engage in conversation without becoming preoccupied with how they were perceived, allowing participants to focus more on the content of what they wanted to say.

Furthermore, the interface's button-triggered gestures, such as clapping, nodding, or waving, allowed participants to communicate or affirm others without relying solely on spoken language. These gestures were especially valuable when users experienced difficulty verbalizing their thoughts or felt emotionally overwhelmed. The nonverbal options built into the system enabled more continuous and nuanced interaction by offering alternative channels of expression. Even participants who reported low energy or discomfort with speaking could remain engaged through these supportive interaction tools.

> *"Pressing a button, it would perform actions... I thought that was fun."*

Some participants found that the presence of robot gestures, including more playful ones like flapping arms or appearing shy, introduced a lightness into the communication flow. These elements created space for humor, creativity, and relaxed interaction, which in turn helped reduce tension. Several participants mentioned that this type of communication felt easier and more authentic than in past therapeutic experiences, where the direct presence of others often led them to withhold difficult or complex thoughts.

> *"I could quite easily focus and think of what I want to convey."*

Overall, the system created a more stable and manageable environment for communication. Participants could initiate dialogue without fear of interruption, misunderstanding, or social missteps. The result was a communication experience that was more expressive, less inhibited, and better suited to individuals dealing with anxiety and self-consciousness around social interaction.

5.1.2 Emotional Comfort and Psychological Safety

The OriHime system provided participants with a strong sense of emotional security. By removing the need to be physically seen, the setup reduced pressure related to body image and facial expression. Each participant joined the session from a separate room, which helped prevent social comparison and reduced the anxiety often associated with group therapy.

> *"I get really nervous in front of people, but with the robot, it felt calmer."*

Many users felt more at ease knowing they would not be visually evaluated. The consistent and predictable movements of the avatars eliminated the stress of interpreting subtle human expressions. For some, this made staying calm and engaged throughout the session easier. Others noted that it was easier to open up because the emotional stakes felt lower in the absence of direct eye contact or visible reactions from others.

> *"Not seeing others' faces helped me stop comparing myself."*

> *"I could talk freely because everyone was the same."*

The physical separation also reduced overstimulation. Participants could focus on the conversation without feeling overwhelmed by their environment or the presence of other people. Several mentioned that being in control of their communication, whether it be speaking or using gestures, helped them manage emotional fatigue and maintain participation even during complex topics.

> *"Even if I was crying behind the screen, the robot wouldn't show it."*

The OriHime setup allowed users to feel psychologically safe. The system's structure reduced visual and social pressure, which in turn supported more stable emotional engagement throughout the sessions.

5.1.3 Avatar Perception and Body Image Relief

Several described the robot's appearance as cute and gentle, contributing to a more approachable and emotionally safe environment. Some compared the avatar's hands to those of a penguin, and many appreciated its simple, cartoon-like form. These features softened the experience and allowed users to feel less judged or scrutinized. For individuals who often experience intense discomfort about how they are seen by others, the design created a sense of emotional distance from their own physical appearance.

Relief from being seen was repeatedly mentioned across sessions. The knowledge that others could not view their body or facial expressions provided a unique sense of safety. Visual anonymity was beneficial in a group therapy setting, where participants often worry about how they compare to others. With each person placed in a separate room and represented by an identical, neutral-looking robot, the opportunity for comparison was effectively removed. Participants were able to focus on conversation rather than how they might appear to others, which helped reduce self-monitoring and stress.

> *"It was easier to talk when no one could see me."*

Without the need to manage facial expressions or body posture, participants felt they could engage more comfortably. Several described the experience as freeing. The absence of mirrors or real-time feedback allowed them to forget about their appearance for a while, breaking from the usual anxiety surrounding body image and making space for more honest participation.

The OriHime system created a buffer between the participant and the gaze of others. By redirecting attention away from the physical self, the avatar allowed users to speak and listen without fear of judgment. For individuals with eating disorders, who often face daily challenges related to body image, this shift in focus provided meaningful relief and supported deeper emotional participation in the therapeutic process.

5.1.4 User Experience and System Usability

Participants generally found the OriHime system intuitive and easy to operate. The interface provided on the iPad allowed users to control the robot with minimal

effort. Most participants were able to learn the basic functions, such as moving the head, activating gestures, and speaking through the microphone, without extensive guidance. The simple design and limited control set helped reduce cognitive load, making the system accessible even for users who were unfamiliar with similar technologies.

"[Even though it's a robot] it didn't feel mechanical. I could speak normally, and it [words] would come out, just like a normal conversation."

Despite the overall ease of use, some participants experienced minor difficulties in fine-tuning the robot's gestures or direction. A few noted that they were unsure how to use certain buttons or forgot to trigger reactions during conversation. These issues were not perceived as major obstacles, but they did suggest the need for clearer instructions or a short practice session before the main activity.

> *"Even if I wanted to press something quickly, I had to scroll down, so I missed the timing."*

In terms of system performance, the robot and application remained technically stable throughout the sessions. Participants did not report significant delays or failures in connection, and the interactions proceeded without interruption.

Several users appreciated that the gestures, though limited, felt expressive enough to support interaction. Others felt that the ability to nod, wave, or clap added value, especially when verbal communication was difficult. Suggestions for improvement included adding more gesture options and increasing the responsiveness of movement. A few also proposed a way to better distinguish between robots, either through custom names or more individualized features.

5.2. Therapist Evaluation, Feedback, and Suggestions

Therapist interviews provided critical insight into the practical and clinical impact of the OriHime system. Their feedback helped contextualize participant experiences and highlighted specific areas for technical and design refinement. Overall, the therapists expressed a mix of enthusiasm and caution, recognizing the sys-

tem's promise while identifying important limitations and future directions. The following subsections outline the key themes raised during these discussions.

5.2.1 General Impressions of the OriHime System

The Yokohama City University therapist team responded positively to the system's ability to support participation from patients who typically experience discomfort in face-to-face settings. From their clinical perspective, the OriHime sessions helped create a low-pressure environment that encouraged more verbal engagement than usual. They observed that some participants appeared more relaxed and communicative when using the avatar than in-person interactions. The therapists emphasized that these outcomes seemed tied to the reduced visual burden and increased sense of psychological distance provided by the OriHime setup.

5.2.2 Identification with the Avatar

However, therapists expressed several important reservations and suggestions. One key concern raised by the supervising psychiatrist was that patients might not fully identify with the robot. The emotional connection remained limited since they did not spend extended time with their OriHime or have prior experience using it. To address this, the main psychiatrist strongly recommended developing ways for participants to become more familiar with their avatar. For example, giving patients the opportunity to interact with the robot outside of therapy, in a casual or playful setting, might improve the sense of personal attachment. Events modeled after existing OriHime-based social activities, such as sports games, were cited as promising examples.

5.2.3 Suggestions for Personalization

Therapists also suggested that enabling participants to personalize their avatar could strengthen feelings of ownership and self-representation. Possible customization ideas included selecting a preferred light color, adding accessories like headbands, ribbons, or charms. Designing and putting clothing onto the avatar could

also reflect individual identity. These options would not only offer an element of enjoyment but also help participants feel that the robot truly represents them, reinforcing the sense that the avatar is an extension of themselves.

5.2.4 Immersion and Gesture Control

In a separate interview after the study, the therapist team noted a lack of immersive presence in the robot-mediated sessions. Compared to virtual reality, the OriHime robots did not provide participants with the same sense of embodiment. One limitation was the fixed range of pre-programmed gestures, which did not allow for real-time expressive movement. The therapists explained that the system lacked gesture control mirroring, which refers to the ability to move one's own hands and see the avatar replicate those movements live. This kind of interaction, similar to how gesture-based smart mirrors work, would help users feel more physically connected to the avatar. Without it, participants were less likely to experience the robot as an extension of themselves. To improve future implementations, the team recommended introducing gesture mirroring, expanding the available gestures, and allowing more fluid and intuitive controls.

5.2.5 Reflections on Clinical Value

While the therapist team acknowledged the value of OriHime in supporting emotional expression and participation, they also emphasized that these tools should not be treated as substitutes for patient voice. They preferred to center the direct experiences of users when evaluating therapeutic success. Still, the therapists expressed optimism about the technology's potential, particularly if future versions better support user identification, agency, and immersion.

Chapter 6
Discussion

6.1. Reducing Appearance-Based Barriers

The use of OriHime in therapeutic settings showed strong potential to address longstanding challenges in eating disorder treatment, particularly those tied to visual exposure and body-related distress. By removing the requirement for participants to appear physically in front of others, the system helped eliminate one of the most significant deterrents to participation in group therapy. The separation of participants into private rooms and their representation through visually neutral robots allowed the sessions to proceed without the social comparisons that can be triggering in traditional group formats.

Participants consistently engaged more freely when they were not subject to gaze or judgment based on their appearance. The visual detachment fostered a sense of safety that supported open dialogue. These findings align with previous literature that emphasizes how physical presence and appearance anxiety can inhibit participation in therapeutic contexts, particularly for individuals with eating disorders [1,8]. In contrast to work that explored online or text-based anonymity in disordered eating communities [8,18], the robot-based system preserved a sense of real-time embodied presence while still removing appearance-based pressure. This suggests that physical avatars can enable more situated, emotionally grounded interaction than disembodied text, without requiring visual exposure.

6.2. Design Implications for Robot-Mediated Therapy

Several insights from the study point to important design principles for future development. The simplicity and cuteness of the avatar played a central role in reducing tension and promoting emotional engagement. A robot that is non-threatening and visually gentle can help lower psychological resistance to participation. This echoes prior work that highlights the importance of "soft" and approachable design in therapeutic technologies [9, 10].

Participants benefitted from having both verbal and nonverbal tools for communication. The inclusion of gesture-based expressions, such as clapping or nodding, allowed users to participate even when verbalization became difficult. To further enhance the system, more intuitive control schemes and customizable features should be explored. Adding personalization elements, such as avatar decoration or color selection, could help build stronger identification with the robot. Such personalization was previously found to enhance emotional attachment and embodiment in avatar-based systems [11, 27], and the present findings reaffirm its therapeutic relevance in clinical settings. Whereas prior work explored these dynamics in classroom or workplace settings [11], this study confirms that personalization also enhances emotional comfort and identification in therapeutic contexts where users are highly self-conscious about appearance.

Therapists also raised valuable concerns about immersion and embodiment. The current OriHime system lacked the ability to mirror a user's real-time movements, which may have limited the participants' sense of being "present" through the avatar. Incorporating gesture mirroring and more dynamic interaction could help bridge this gap and increase emotional connection between the user and their representation. This echoes findings by Choi and Kwak [25] and Almeida et al. [26], who observed that gesture timing and movement fluency strongly influence perceived presence. While those studies focused on social or educational interactions, the present study extends their insights to clinical environments where expressive presence is emotionally charged.

6.3. Technical and Design Directions

One of the most frequently suggested improvements was to increase the users' sense of ownership and identification with the avatar. Future systems should allow users to spend more time with their robot outside of therapy sessions. Informal or recreational interactions, such as those seen in OriHime-based social events, may support deeper emotional attachment and greater comfort with the interface.

Customization was also highlighted as an important opportunity. Allowing users to choose their robot's light color or decorate it with small accessories may help the avatar feel more personal and reflective of the user's identity. These low-cost enhancements could strengthen the perception of the robot as an extension of the self, thereby improving emotional engagement.

From a technical standpoint, improving gesture control is a key priority. Therapists observed that the limited movement vocabulary of the current OriHime system restricted expressiveness. Future designs should consider adding gesture mirroring functionality, where users can move their hands and have the avatar replicate those motions in real time. This would enhance embodiment and increase the feeling of being present through the robot.

In addition, interface usability should continue to be refined. Although most participants adapted quickly to using the system, smoother onboarding processes and simpler gesture control mechanisms would help make the platform more accessible to a wider range of users.

6.4. Limitation

The study's findings are subject to several limitations. The sample size remained relatively small, and all participants were recruited from a single hospital. The sessions were short-term and simulated, limiting understanding of long-term effects or real-world sustainability. Because the avatars were unfamiliar to the participants prior to the study, the lack of personal connection with the robots may have influenced the outcomes. Additionally, the study relied heavily on qualitative feedback, which provides valuable insight but cannot fully capture behavioral change or clinical outcomes.

Another limitation was the constrained gesture vocabulary of the avatars. Although participants appreciated the expressive tools that were available, the inability to control the robots with more fluid, personalized movement reduced the potential for immersive interaction.

6.5. Future Work

Building on the findings of this study, several directions for future research and development can be proposed to improve the therapeutic use of robot avatars. These include both system-level innovations and broader methodological considerations for robot-mediated mental health support.

This study builds on existing work in therapeutic HCI, but it introduces a distinct contribution by exploring physical embodiment for people with eating disorders, a group underrepresented in robot-mediated therapy research. While prior studies have investigated telepresence, anonymity, or peer support online [6,8], few have examined how robot avatars might create safer group spaces for patients with appearance-based vulnerabilities. Findings suggest that robot-mediated systems can not only replicate social interaction but also reshape the emotional contours of that interaction. By removing physical co-presence while preserving mutual awareness and responsiveness, these systems open new opportunities for inclusive therapeutic design.

More broadly, this work contributes to ongoing discussions in HCI about how embodiment, visibility, and identity intersect in digital health interventions. The decoupling of social presence from physical appearance points to new design possibilities for therapeutic systems that prioritize emotional safety. Researchers developing tools for other marginalized populations, such as those with physical disabilities, trauma-related conditions, or social anxiety, may benefit from exploring similar approaches that reduce exposure while preserving agency. Furthermore, the study demonstrates that customization and control over one's representation are not merely aesthetic preferences but can serve as core mechanisms for emotional engagement. Future work in Human–Computer Interaction and digital mental health should more deeply consider the psychological dimensions of embodiment and representation, especially when designing for users whose appearance

is entangled with distress. By prioritizing user comfort, perceived presence and agency, future systems can become more adaptable and emotionally responsive across a range of therapeutic contexts.

Chapter 7
Conclusion

This thesis explored the use of robot avatars to reduce appearance-related barriers in group therapy for individuals with eating disorders. By developing and testing a custom OriHime-based therapy system, the study demonstrated that remote embodiment through visually neutral robots can help create a psychologically safe environment. Across both therapist and participant responses, the system was shown to lower visual and social pressure, supporting more open and emotionally engaged communication.

Participants reported that the avatar reduced anxiety, improved self-expression, and allowed them to participate without the burden of being seen. The robot's gestures and nonthreatening design helped many users feel more relaxed and comfortable, especially when discussing sensitive topics. The system's structure further supported emotional security. Users remained physically separated and interacted through a stable, nonjudgmental interface. These design elements collectively helped reduce the intensity of body image stress during sessions.

Therapists viewed the system as effective in promoting verbal engagement in patients who are typically reluctant to participate in face-to-face settings. However, they also noted limitations in immersion and self-identification. Suggestions for improvement included adding personalization features, gesture mirroring, and opportunities for participants to build familiarity with the robot over time. These insights point toward concrete directions for enhancing future implementations.

Overall, the study highlights the therapeutic potential of robot-mediated interaction in contexts where visibility, body image, and social presence can become barriers to care. The findings suggest that avatar robots, when carefully designed and implemented, can help expand access to mental health care for individuals who find conventional therapy settings intimidating or inaccessible due to social or psychological factors.

References

[1] Daphne van Hoeken and Hans W. Hoek. Review of the burden of eating disorders: Mortality, disability, costs, quality of life, and family burden. *Current Opinion in Psychiatry*, 33(6):521–527, 2020.

[2] National Eating Disorders Association. What are eating disorders?, 2024. Accessed December 2024. URL: `https://www.nationaleatingdisorders.org/what-are-eating-disorders/`.

[3] Kyoko Nomura, Yuki Itakura, Sachiko Minamizono, et al. The association of body image self-discrepancy with female gender, calorie-restricted diet, and psychological symptoms among healthy junior high school students in japan. *Frontiers in Psychology*, 12:576089, 2021.

[4] International Association of Eating Disorders Professionals Foundation. The rise of eating disorders in asia, 2024. Accessed December 2024. URL: `https://edr.iaedpfoundation.com/the-rise-of-eating-disorders-in-asia/`.

[5] Tasuku Kitajima, Jumpei Iwanami, Ryoko Otani, Takeshi Inoue, Ayako Sugawara, Kiyo Hattori, Shizuo Takamiya, Mari Suzuki, and Ryoichi Sakuta. Perspectives from school health settings on the eating disorder-related behaviors of children and adolescents in the covid-19 pandemic. *Japanese Journal of Eating Disorders*, 4(1):13–25, 2024.

[6] Pranita Shrestha, Pari Delir Haghighi, Gemma Sharp, Jue Xie, and Roisin McNaney. One size (doesn't) fit all: Exploring design considerations for digital body dissatisfaction interventions with underrepresented populations. In *Proceedings of the 2024 ACM Designing Interactive Systems Conference*, DIS '24, pages 3534–3550, 2024.

[7] Liza Gak, Seyi Olojo, and Niloufar Salehi. The distressing ads that persist: Uncovering the harms of targeted weight-loss ads among users with histories of disordered eating. *Proceedings of the ACM on Human-Computer Interaction*, 6(CSCW2):23, 2022.

[8] Jessica L. Feuston, Michael Ann Devito, Morgan Klaus Scheuerman, Katy Weathington, Marianna Benitez, Bianca Z. Perez, Lucy Sondheim, and Jed R. Brubaker. "do you ladies relate?": Experiences of gender diverse people in online eating disorder communities. *Proceedings of the ACM on Human-Computer Interaction*, 6(CSCW2):1–27, 2022.

[9] Giulia Barbareschi, Midori Kawaguchi, Hiroaki Kato, Masato Nagahiro, Kazuaki Takeuchi, Yoshifumi Shiiba, Shunichi Kasahara, Kai Kunze, and Kouta Minamizawa. "I am both here and there" parallel control of multiple robotic avatars by disabled workers in a café. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI '23, pages 75:1–75:17, 2023.

[10] Yuji Hatada, Giulia Barbareschi, Kazuaki Takeuchi, Hiroaki Kato, Kentaro Yoshifuji, Kouta Minamizawa, and Takuji Narumi. People with disabilities redefining identity through robotic and virtual avatars: A case study in avatar robot cafe. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, CHI '24, page 13, 2024.

[11] Houda Elmimouni, Amy Kinney, Elizabeth C. Brooks, Hannah Li, and Selma Sabanovic. "Who's that?": Identity self-perception and projection in the use of telepresence robots in hybrid classrooms. In *Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction*, HRI '23, pages 287–291, 2023.

[12] Julia Ayache, Marta Bieńkiewicz, Kathleen Richardson, and Benoit Bardy. extended reality of socio-motor interactions: Current trends and ethical considerations for mixed reality environments design. In *Companion Publication of the 25th International Conference on Multimodal Interaction*, ICMI '23 Companion, pages 154–158, 2023.

[13] COI-NEXT Keio Project. Coi-next program: Keio university, 2025. Accessed July 26, 2025. URL: `https://coinext.sfc.keio.ac.jp/`.

[14] Lisa Wagensveld, Christof van Nimwegen, and Sander Bakkes. Identifying body appreciation by visualising actual/ideal self-discrepancy: An avatar creation task. In *Proceedings of the 18th International Conference on the Foundations of Digital Games*, FDG '23, pages 34:1–34:11, 2023.

[15] Giuseppe Riva and L. Melis. Virtual reality for the treatment of body image disturbances. *Studies in Health Technology and Informatics*, 44:95–111, 1997.

[16] Anouk Keizer, Anouk van Elburg, Roger Helms, and H. Chris Dijkerman. A virtual reality full body illusion improves body image disturbance in anorexia nervosa. *PLOS ONE*, 11(10):e0163921, 2016.

[17] Jessica Portingale, Isabel Krug, and David Butler. Whose body is it anyway? cultural reflections on embodiment illusion research in eating disorders and body dysmorphic disorder. *Frontiers in Psychiatry*, 15:1433596, 2024.

[18] Fayika Farhat Nova, Amanda Coupe, Elizabeth D. Mynatt, Shion Guha, and Jessica A. Pater. Cultivating the community: Inferring influence within eating disorder networks on twitter. *Proceedings of the ACM on Human-Computer Interaction*, 6(GROUP):7:1–7:33, 2022.

[19] Jessica Downey. Group therapy for adolescents living with an eating disorder: A scoping review. *SAGE Open*, 4:1–11, 2014.

[20] Lala Guluzade and Corina Sas. Functionality and user review analysis of mobile apps for mindfulness eating and eating disorders. In *Proceedings of the 2024 ACM Designing Interactive Systems Conference*, DIS '24, pages 1350–1371, 2024.

[21] Jessica A. Pater, Oliver L. Haimson, Nazanin Andalibi, and Elizabeth D. Mynatt. "Hunger Hurts but Starving Works": Characterizing the presentation of eating disorders online. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, CSCW '16, pages 1185–1200, 2016.

[22] Lauren C. Taylor, Kelsie Belan, Munmun De Choudhury, and Eric P. S. Baumer. Misfires, missed data, misaligned treatment: Disconnects in collaborative treatment of eating disorders. *Proceedings of the ACM on Human-Computer Interaction*, 5(CSCW):Article 31, 1–28, 2021. doi:10.1145/3449105.

[23] Ai Kashii, Kazunori Takashio, and Hideyuki Tokuda. Ex-amp robot: Physical avatar for enhancing human to human communication. In *Proceedings of the Fourth International Conference on Human Agent Interaction*, HAI '16, pages 89–92, 2016.

[24] Marte Nordtug and Lars E. Johannessen. The Social Robot? Analyzing whether and how the telepresence robot AV1 affords socialization. *Convergence*, 29(6):1683–1697, 2023.

[25] Jung Ju Choi and Sonya S. Kwak. Who is this?: Identity and presence in robot-mediated communication. *Cognitive Systems Research*, 43:174–189, 2017.

[26] Luis Almeida, Paulo Menezes, and Jorge Dias. Telepresence social robotics towards co-presence: A review. *Applied Sciences*, 12(11):5557, 2022.

[27] Giulia Barbareschi, Midori Kawaguchi, Hiroaki Kato, Kazuaki Takeuchi, Masato Nagahiro, Yoshifumi Shiiba, Yoshifuji Ory, Shunichi Kasahara, and Kouta Minamizawa. Accessible parallel embodiment of multiple robotic avatars in a cafe. *XRDS: Crossroads, The ACM Magazine for Students*, 29(2):36–41, 2022.

[28] OryLab Inc. Orylab official website. https://orylab.com, 2025. Accessed: July 28, 2025.

[29] Ryota Yamamoto, Haruna Sekimoto, and Kenichi Kubota. Studying a telepresence robot installed into a hospital classroom. volume 10, pages 53–62, 2016.

[30] Stefan Vikkelsø, Tuyet-Hoa Hoang, Fransine Carrara, Karl Hansen, and Birthe Dinesen. The telepresence avatar robot OriHime as a communica-

tion tool for adults with acquired brain injury: An ethnographic case study. *Intelligent Service Robotics*, 13:521–537, 2020.

[31] Yūji Sone. Orihime robot avatars, affect, and performance. In *The Future of Humans and Emotional Machines*, page 163. Routledge, 2025.

Appendices

Participant Interview Questions

This section presents the interview questions used in the study, posed to participants to gather insight on their experiences with the OriHime avatar robot during therapy.

1. Did using the OriHime avatar robot during the in-depth hearing session have any impact on your own body image perception? Why or why not?
2. To what extent did the process of using the OriHime avatar help you freely express yourself?
3. How do you think the use of the avatar robots impacted your experience of the in-depth therapy session?
4. What has been your overall experience with the OriHime avatar robot? Which aspects did you like, and which did you find challenging or in need of improvement?
5. Do you think that the use of OriHime avatar robots could positively impact the access and experiences of mental health therapy sessions for people with eating disorders? Why or why not?

Japanese and English Questions from Therapist-Led Sessions

The following set of questions, developed in collaboration with clinicians, were presented to participants during the therapist-led sessions. The questions were originally written in Japanese and are accompanied here by their English translations.

Pre-Session Evaluation (Rated on a 1–7 scale)

English Translation

1. How useful is dialogue using a robot avatar for self-expression?
2. Did the robot avatar raise or lower the hurdle for ease of participation in mental health therapy sessions? How did you feel?
3. What was your overall experience with the robot avatar? What did you like, what were the challenges, and what needs improvement?
4. Do you think the robot avatar is useful for mental health therapy sessions, especially for people with eating disorders? Is it not useful? Why do you think so?
5. By expressing yourself through a robot avatar, what impact or change did it have on your body image?

Post-Study Interview with Main Psychiatrist

1. General Background

1. Can you tell us some basic information about your experience working with people with eating disorders in Japan?
2. What is the care pathway for these patients?

- How are they identified?
- Which doctors and medical professionals are part of the care team?
- What are the recommended standard services offered, especially from a mental health point of view?

3. Have you observed any notable trends in the gender or age of patients in your practice?
4. Have you noticed changes in the way eating disorders are treated or understood over the course of your career?
5. Is the situation in Japan different from other countries based on your experience?
6. Are group therapy sessions part of the treatment that patients with eating disorders can access?
    - What are the advantages of group therapy for this particular group?

2. Body Image Issues and Therapy

1. Body image issues are an essential concern for those with eating disorders. Do you think that interacting with others during group therapy sessions is affected by such issues?
2. What positive and negative changes do you think utilizing a robot avatar for communication during group therapy might have for these clients?

3. Regarding Participant Selection

1. Can you provide details on the selection criteria you used to choose the participants?
2. What factors were considered in the selection process?
3. Were the selected participants patients you had been following for a long time?

4. Were patients recommended because you felt they might particularly benefit from OriHime?

5. Were participants chosen to represent a broad range of experiences, or were they selected for specific traits?

    - For example, comfort with technology or communication challenges?

6. Were the participants at different stages of their recovery?

    - Did the system's impact vary across a spectrum of needs?

4. Post-Study Impressions

1. Have you had any follow-ups with these participants since their involvement in the study?

2. If yes, did they share any reflections or impressions about the experience?

3. Did the patient's participation in the study reflect any noticeable changes?

Post-Study Interview with YCU Therapist Team

Communication / Emotional Expression

1. **EN:** Did you personally feel more comfortable conducting therapy sessions through OriHime, or did you find in-person sessions more effective in terms of emotional connection and therapeutic communication with the patient?

2. **EN:** In your experience, did patients communicate differently through OriHime compared to real (in-person) sessions? Did you notice any changes in their tone, openness, or emotional expression?

3. **EN:** Were there moments when patients shared things they might usually be reluctant to share in traditional therapy settings?

4. **EN:** Did the OriHime setup ever make communication more difficult or less natural?

Group Dynamics

5. **EN:** Do you think using identical avatars helped reduce appearance-based concerns or social comparison between participants?

6. **EN:** Did using avatars affect how patients viewed themselves in the group? How did it influence the group dynamic overall?

Clinical Impact / Engagement

7. **EN:** Compared to real sessions, did the OriHime format give you different insights into patients' emotional or psychological states?

8. **EN:** Did OriHime sessions shift any typical dynamics you observe in therapy (silence, shyness, or oversharing)?

Design Feedback

9. **EN:** Was the interface, such as the tablet and gesture controls, easy for patients to use and understand?

10. **EN:** Were there any usability issues or technical problems that affected the flow of the sessions?

Session Schedule Details

The following pages present the full session schedule used during the first user study.

1回目 10時～　対面（+ロボットアバター希望者）　※ハンドラーはパネルに伴走、高瀬先生、保坂さん、中山で各部屋を担当。

コンテンツ	開始時刻	終了時刻	所要時間(分)	担当	内容
正門集合	9:50	10:00	10	ハンドラー	個別会場へ入室（ハンドラーが連れて行く）
謝金の手続き	10:00	10:10	10	ハンドラー	個人情報の記入、本人確認書類の確認
研究の説明	10:10	10:15	5	ハンドラー	
機器装着	10:15	10:20	5	ハンドラー	血圧計・皮膚伝導測定器・Garminを装着、電源オンにし測定開始
生体サンプリング SUD①	10:20	10:25	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
安静期	10:25	10:30	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD②	10:30	10:35	5	ハンドラー	血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
部屋移動	10:35	10:40	5	ハンドラー	ヒアリング会場へ
ヒアリング	10:40	11:00	20	名越	ヒアリングテーマ「自己紹介（ニックネーム）と今週の出来事」 心理士が傾聴、 ヒアリングはすべて録音測定（音声ではなく発話時間を記録）
部屋移動	11:00	11:05	5	ハンドラー	元の個室に戻る
生体サンプリング SUD③	11:05	11:10	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
安静期	11:10	11:15	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD④	11:15	11:20	5	ハンドラー	血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
機器取外	11:20	11:25	5	ハンドラー	HMD・皮膚伝導測定器・Garminを取り外す
ロボットアバター希望確認	11:25	11:30	5	ハンドラー	ロボットアバターの体験確認
ロボットアバターの操作確認	11:30	11:40	10	ハンドラー	iPad操作確認
ヒアリング	11:40	11:46	6	名越	ヒアリングテーマ「自己紹介（ニックネーム）と今週の出来事」 心理士が傾聴、 ヒアリングはすべて録音測定（音声ではなく発話時間を記録）
ロボットアバターインタビュー	11:46	12:01	15	ハンドラー	ロボットアバターのインタビューを実施
謝金の手続き	12:01	12:06	5	中山	Amazonギフトの送付先メールアドレス確認・受領の手続き説明
終了		12:06	111		

2回目 13時～　ロボットアバター　※調整中　※ハンドラーはパネルに伴走、高瀬先生、保坂さん、中山で各部屋を担当。

コンテンツ	開始時刻	終了時刻	所要時間(分)	担当	内容
正門集合	12:50	13:00	10	ハンドラー	個別会場へ入室（ハンドラーが連れて行く）
謝金の手続き	13:00	13:10	10	ハンドラー	個人情報の記入、本人確認書類の確認
研究の説明	13:10	13:15	5	ハンドラー	
ロボットアバター操作説明	13:15	13:25	10	ハンドラー	iPad操作説明
機器装着	13:25	13:30	5	ハンドラー	血圧計・皮膚伝導測定器・Garminを装着、電源オンにし測定開始
生体サンプリング SUD①	13:30	13:35	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
安静期	13:35	13:40	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD②	13:40	13:45	5	ハンドラー	血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
ロボットアバターの操作確認	13:45	13:55	10	ハンドラー	iPad操作確認
ヒアリング	13:55	14:07	12	名越	ヒアリングテーマ「自己紹介（ニックネーム）と今週の出来事」 心理士が傾聴、 ヒアリングはすべて録音測定（音声ではなく発話時間を記録）
生体サンプリング SUD③	14:07	14:12	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
安静期	14:12	14:17	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD④	14:17	14:22	5	ハンドラー	血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
機器取外	14:22	14:27	5	ハンドラー	HMD・皮膚伝導測定器・Garminを取り外す 録音開始
ロボットアバターインタビュー	14:27	14:42	15	ハンドラー	ロボットアバターのインタビューを実施
謝金の手続き	14:42	14:47	5	中山	Amazonギフトの送付先メールアドレス確認・受領の手続き説明
終了		14:47	117		

3回目 15時～　対面（+ロボットアバター希望者）　※ハンドラーはパネルに伴走、高瀬先生、保坂さん、中山で各部屋を担当。

コンテンツ	開始時刻	終了時刻	所要時間(分)	担当	内容
正門集合	14:50	15:00	10	ハンドラー	個別会場へ入室（ハンドラーが連れて行く）
謝金の手続き	15:00	15:10	10	ハンドラー	個人情報の記入、本人確認書類の確認
研究の説明	15:10	15:15	5	ハンドラー	
機器装着	15:15	15:20	5	ハンドラー	血圧計・皮膚伝導測定器・Garminを装着、電源オンにし測定開始
生体サンプリング SUD①	15:20	15:25	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
安静期	15:25	15:30	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD②	15:30	15:35	5	ハンドラー	血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
部屋移動	15:35	15:40	5	ハンドラー	ヒアリング会場へ
ヒアリング	15:40	16:00	20	名越	ヒアリングテーマ「自己紹介（ニックネーム）と今週の出来事」 心理士が傾聴、 ヒアリングはすべて録音測定（音声ではなく発話時間を記録）
部屋移動	16:00	16:05	5	ハンドラー	元の個室に戻る
生体サンプリング SUD③	16:05	16:10	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
安静期	16:10	16:15	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD④	16:15	16:20	5	ハンドラー	血圧（上腕式血圧計） 不安SUD測定→不安度0（不安なし）から10（強い不安あり）の中で近い数値を回答 唾液採取
機器取外	16:20	16:25	5	ハンドラー	HMD・皮膚伝導測定器・Garminを取り外す
ロボットアバター希望確認	16:25	16:30	5	ハンドラー	ロボットアバターの体験確認
ロボットアバターの操作確認	16:30	16:40	10	ハンドラー	iPad操作確認
ヒアリング	16:40	16:46	6	名越	ヒアリングテーマ「自己紹介（ニックネーム）と今週の出来事」 心理士が傾聴、 ヒアリングはすべて録音測定（音声ではなく発話時間を記録）
ロボットアバターインタビュー	16:46	17:01	15	ハンドラー	ロボットアバターのインタビューを実施
謝金の手続き	17:01	17:06	5	中山	Amazonギフトの送付先メールアドレス確認・受領の手続き説明
終了		17:06	111		

1回目 10時～	ロボットアバター				※ハンドラーはパネルに伴走。高瀬先生、保坂さん、中山で各部屋を担当。
コンテンツ	開始時刻	終了時刻	所要時間(分)	担当	内容
正門集合	9:50	10:00	10	ハンドラー	個別会場へ入室(ハンドラーが連れて行く)
謝金の手続き	10:00	10:10	10	ハンドラー	個人情報の記入、本人確認書類の確認
研究の説明	10:10	10:15	5	ハンドラー	
ロボットアバター操作説明	10:15	10:25	10	ハンドラー	iPad操作説明
機器装着	10:25	10:30	5	ハンドラー	血圧計・皮膚伝導測定器・Garminを装着。電源オンにし測定開始
生体サンプリング SUD①	10:30	10:35	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧(上腕式血圧計) 不安SUD測定→不安度0(不安なし)から10(強い不安あり)の中で近い数値を回答 唾液採取
安静期	10:35	10:40	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD②	10:40	10:45	5	ハンドラー	血圧(上腕式血圧計) 不安SUD測定→不安度0(不安なし)から10(強い不安あり)の中で近い数値を回答 唾液採取
ロボットアバターの 操作確認	10:45	10:55	10	ハンドラー	iPad操作確認
ヒアリング	10:55	11:15	20	名越	ヒアリングテーマ「自己紹介(ニックネーム)と今週の出来事」 心理士が傾聴。 ヒアリングはすべて録音測定(音声ではなく発話時間を記録)
生体サンプリング SUD③	11:15	11:20	5	ハンドラー	セルフコンパッション尺度の記入を依頼 血圧(上腕式血圧計) 不安SUD測定→不安度0(不安なし)から10(強い不安あり)の中で近い数値を回答唾
安静期	11:20	11:25	5	ハンドラー	5分間なにもせずに安静
生体サンプリング SUD④	11:25	11:30	5	ハンドラー	血圧(上腕式血圧計) 不安SUD測定→不安度0(不安なし)から10(強い不安あり)の中で近い数値を回答 唾液採取
機器取外	11:30	11:35	5	ハンドラー	HMD・皮膚伝導測定器・Garminを取り外す 録音開始
ロボットアバター インタビュー	11:35	11:50	15	ハンドラー	ロボットアバターのインタビューを実施
謝金の手続き	11:50	11:55	5	中山	Amazonギフトの送付先メールアドレス確認・受領の手続き説明
終了		11:55	125		