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Exploring the Role of Robots in Interactive Art with the Silver Generation

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Abstract: This study investigates the integration of intelligent assistants in mediating communication for elderly couples, focusing on addressing key barriers such as emotional expression difficulties, listening inconsistency, insufficient emotional support, conflict resolution challenges, trust issues, and decision-making differences. It proposes three roles for intelligent assistants—mediation assistant, autonomous third-party assistant, and external contact proxy assistant, that aim to improve communication, facilitate conflict resolution, and foster emotional bonds by addressing both internal and external influences. While intelligent assistants are often used to support social engagement and alleviate loneliness, most research focuses on individual interactions or telepresence rather than the dynamics of elderly couples. Through a mixed-methods approach, this study examines communication patterns and conflict resolution strategies, followed by participatory design to explore elderly couples' preferences and potential scenarios for intelligent assistants as mediators. The findings provide valuable insights for designing intelligent assistants tailored to cultural and gender-specific differences in communication dynamics.

Keywords: Intelligent Assistants; Elderly Couples; Communication Barriers; Conflict Resolution; Emotional Support.

1. Research Background and Significance

1.1. Growth Trend of the Elderly Population and Communication Needs

Social interaction among older adults has been a central focus in Human-Computer Interaction (HCI) research due to its importance for their well-being [39]. While previous studies have mainly examined interactions with technology and social engagement in elderly groups, this study shifts focus to elderly couples, exploring the dynamics of their daily relationships. As global aging trends rise, many older adults rely on home-based care, making spousal relationships their most frequent and stable form of social interaction. Despite the HCI field's emphasis on intimate relationships, research into elderly couples' dynamics remains limited [40].

The harmony of these relationships, encompassing emotional support, conflict resolution, and joint decision-making, greatly impacts quality of life [26]. However, challenges such as hearing loss, cognitive decline, and value differences can lead to communication barriers and emotional distancing, negatively affecting mental health and life satisfaction [41]. To address this, the study introduces "proximal non-intimacy," a phenomenon where emotional barriers persist despite physical closeness, similar to long-distance emotional challenges but in close proximity [38]. This research investigates how elderly couples resolve conflicts and maintain positive communication, aiming to inspire the HCI field to address their complex communication needs shaped by factors such as age, gender, and social conditions. Technologically mediated emotional communication and conflict resolution design provide important insights for developing aging-related solutions [35].

1.2. Current Applications of Artificial Intelligence in Elderly Communication

The application of artificial intelligence (AI) in elderly communication is rapidly expanding, addressing key challenges like communication barriers, social isolation, and emotional support deficits. AI offers innovative solutions, helping older adults overcome physiological and cognitive issues such as hearing loss and memory decline, while enhancing connections with family and friends through intelligent interactions. For those living alone or separated from loved ones, AI provides convenient tools like voice and video communication, alleviating loneliness. Advancements in AI have also improved emotional recognition, offering a more human-like interactive experience.

This paper reviews AI technologies in elderly communication, focusing on social robots, telepresence robots, mediation robots, and autonomous robots. Social robots have effectively reduced loneliness by mimicking human interactions, such as the Pepper robot, which provides companionship and improves mental well-being in nursing homes[43]. Telepresence robots facilitate real-time remote communication, allowing elderly individuals to stay connected with family and healthcare providers. Mediation robots serve as neutral facilitators for conflict resolution, easing emotional stress in elderly couples. Autonomous robots offer personalized companionship and support, significantly reducing anxiety and improving life satisfaction. Despite their promise, AI technologies still face challenges, such as low acceptance among older adults and the need for improved emotional recognition and feedback. This study investigates the role of AI assistants in elderly communication, aiming to enhance AI's emotional interaction capabilities.

1.3. Theoretical and Practical Value of This Research

Existing research on AI-mediated communication typically focuses on one-to-one interactions or remote communication, with limited exploration into mediated communication between elderly couples. We believe that with advances in large language models, embodied intelligence, and the growing prevalence of social robots, these robots can be

adapted to home environments and take on the role of a third-party mediator in elderly couples' communication, serving as a socially mediated entity. To address the research gap regarding AI robots facilitating communication between elderly couples, we propose the following theoretical research questions:

- RQ1: What are the challenges and influencing factors in the communication dynamics of elderly couples?
- RQ2: How do elderly couples cope with communication difficulties, and what insights can these strategies provide for the design of AI-mediated communication?
- RQ3: What are the attitudes, needs, and potential socio-emotional impacts of elderly couples towards mediated robots within their communication dynamics?

To answer these research questions, we conducted surveys and interviews to examine the communication dynamics of elderly couples, including communication scenarios, influencing factors, conflict resolution strategies, and relationship maintenance methods. Based on these findings, we propose three intelligent assistants to address the social interactions inherent in these dynamics. Furthermore, through a participatory design process, we explored elderly couples' perceptions, attitudes, and user needs regarding the identity of intelligent assistant. Finally, we reflected on the design implications of using robots as mediators in managing the dynamic relationships of elderly couples. Our research contributions are as follows: 1) We provide an empirical understanding of the social dynamics and communication challenges among elderly couples through surveys and interviews; 2) We propose an exploratory design concept for an adaptive social robot identity; 3) We offer practical evidence on elderly couples' perspectives toward mediated robots through participatory design.

2. Theoretical Foundations of Intelligent Assistant Intervention in Communication

2.1. Communication Models of Intelligent Assistants from an Interdisciplinary Perspective

Mediated social robots facilitate social interaction by assisting users through conversational agents and advanced technologies, offering richer non-verbal cues and multisensory interactions that enhance communication quality [11, 34]. These robots have demonstrated significant potential in improving elderly social interaction in care, companionship, and telepresence contexts [1]. While existing research mainly focuses on single-user interactions, mediated robots can facilitate communication between multiple users and adapt to various social contexts [17].

Telepresence robots, acting as physical surrogates for remote users, are prominent examples, extending social presence in elderly care settings [37]. Other robots function as mediators between communication partners, increasing self-disclosure and facilitating conflict resolution [29, 30]. For instance, the ROMEO system explored using robots with tactile feedback for conflict mediation [16]. However, designing appropriate roles and mediation strategies remains a challenge in human-robot interaction (HRI). Most research emphasizes one-on-one communication, with limited focus on robots mediating elderly couples' interactions. Our interdisciplinary approach explores robots' roles in conflict resolution and communication enhancement for elderly couples, integrating insights from psychology, sociology, and HRI to develop more effective, context-aware intelligent assistants.

For robotic intelligent assistants as mediators in the communication of elderly couples, as shown in Figure 1, we propose three mediated roles for the intelligent assistants to facilitate the dynamic social interaction of elderly couples.

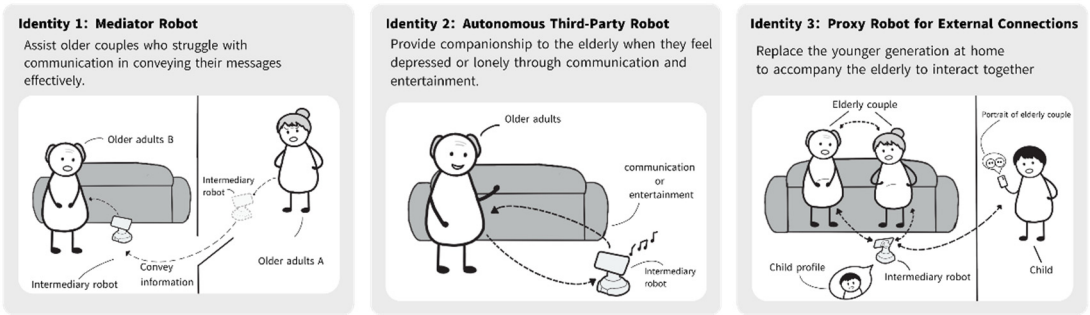


Fig 1. We proposed three identities of intelligent assistant to facilitate older couple's communication:1)Mediator Robot: Acts as a neutral facilitator to improve and clarify communication between elderly couples, accommodating their pace and addressing challenges like hearing loss or memory decline; 2)Autonomous Third-Party Robot: An independent moderator that guides conflict resolution, offers emotional support, and provides companionship for elderly couples, especially for individuals living alone; 3)Proxy Robot: A representative of remote family members, aids in decision-making and enhances the sense of presence

2.2. Human-Computer Interaction and Elderly Psychological Adaptation Theories

Social relationships play a crucial role in the overall health of older adults, encompassing cognitive, emotional, and physical dimensions. Positive social interactions are closely linked to numerous health benefits, including improved mental health, reduced feelings of loneliness, and increased longevity [14]. In the field of Human-Computer Interaction (HCI), interactions with intimate partners are especially important for the emotional well-being of older adults [13]. Research shows that older adults in supportive marital relationships experience lower stress levels and higher well-being [20], which helps them navigate the challenges of aging. However, older adults face significant challenges in maintaining social relationships, particularly as they undergo physiological, psychological, and social changes associated with aging [31]. As marital relationships evolve over time, the

nature of these relationships may shift, highlighting the importance of effective communication and open dialogue to meet needs and resolve conflicts [20].

In elderly couples, disharmony and conflict often arise from multiple complex and interrelated factors [3, 18]. Studies indicate that psychological and sociological factors significantly influence relationship patterns among older couples [13]. Emotional compatibility is a key factor in maintaining harmonious relationships, with couples who exhibit similar emotional needs and expressions reporting higher relationship satisfaction [27]. Intellectual compatibility is also critical, as relationships tend to thrive when partners engage in stimulating conversations and demonstrate mutual respect based on shared interests [2]. Social compatibility, or how partners interact in various social settings, further enhances relationship stability through alignment of lifestyle preferences and social habits [8].

However, there are limitations in the current research on the application of HCI technologies in elderly couples' communication [15, 21]. Existing studies predominantly focus on individual user experiences rather than the interactions between elderly couples [10, 36]. For example, modern communication models such as the Technology Acceptance Model (TAM) [15] may not fully account for the emotional, cognitive, and social barriers faced by elderly couples when using technology. Therefore, HCI design must carefully consider the dynamics of elderly couples' relationships, their communication contexts, and their emotional needs [22]. This approach is essential for developing technological interventions that help older adults adapt to psychological and emotional challenges, ultimately improving their quality of life and emotional well-being.

2.3. The Relationship between Communication Strategies and Intelligent Assistant Design

In intimate relationships, effective communication strategies such as mutual dependency, constructive dialogue, and emotional support are crucial for maintaining healthy interpersonal dynamics and resolving conflicts [33]. Recognizing underlying issues and facilitating constructive conversations fosters trust and understanding between partners [6]. In the field of Human-Computer Interaction (HCI), technologies like social robots and VR simulations have demonstrated potential in conflict resolution and relationship maintenance by offering immersive and interactive experiences [4, 5, 25]. However, existing systems often lack the nuanced emotional intelligence needed to navigate complex relationship histories and deep emotional contexts [9].

Intelligent Assistant, designed to facilitate conflict resolution and enhance communication, show promise by integrating scenarios aligned with relationship maintenance strategies. These robots can prompt prosocial behavior and deeper emotional awareness, making them valuable tools in supporting long-term relational health. Therefore, the design of intelligent assistants should prioritize emotional intelligence, adaptability, and contextual awareness to effectively mediate communication and promote positive interactions in relationships.

3. Analysis of Elderly Communication Needs

3.1. Empirical Research on Elderly Communication Needs

This investigation explored communication patterns, emotional interactions, and conflict resolution strategies among elderly couples, focusing on emotional transparency, mutual understanding, and the impact of health and social changes (Figure 2). An online questionnaire distributed via the Tencent platform in China received 119 responses, with 75.63% of respondents being female and most aged between 60-70. The majority (74.79%) lived with their spouse.

Using a 5-point Likert scale, the questionnaire featured 23 scale questions to assess key communication challenges. Analysis revealed that while most elderly individuals can express emotions easily, some still face barriers. Listening consistency and emotional support were significant issues, with many respondents desiring more openness from their partner. Conflict resolution was lacking, as many preferred to concede rather than argue. Trust issues were also noted, with respondents expressing hesitancy to ask for help or doubts about their partner's honesty. Additionally, disagreements over daily decisions, particularly family matters, were common, leading to conflict or emotional distancing. Overall, the survey highlights key challenges in communication, emotional support, and trust among elderly couples.

3.2. Types and Characteristics of Communication Barriers in the Elderly

Based on empirical research, we have classified communication barriers among the elderly into six types: emotional expression barriers, listening consistency issues, insufficient emotional support, lack of conflict resolution mechanisms, trust issues, and differences in daily decision-making.

Emotional expression barriers: Elderly couples show significant individual differences in emotional expression. While most respondents found it relatively easy to express their emotions to their partner, some elderly individuals encountered challenges in this area. These differences may be related to individual psychological traits, communication skills, and long-established relationship dynamics. Therefore, emotional expression barriers are a significant aspect of communication issues among elderly couples.

Listening consistency issues: Although many elderly partners are able to listen attentively in most situations, the consistency of this listening behavior fluctuates. This inconsistency may be due to distractions, changes in emotional state, or varying levels of interest in the topic, which can affect the continuity and depth of communication.

Insufficient emotional support: Many elderly couples face challenges in providing adequate emotional support, which may stem from suppressed emotional expression, neglect of emotional needs, or a lack of effective support strategies. This insufficiency in emotional support can lead to decreased relationship satisfaction and emotional detachment.

Lack of conflict resolution mechanisms: Many elderly couples tend to adopt avoidance strategies when conflicts arise. While this may serve as a short-term strategy to avoid confrontation, over the long term, it can lead to the accumulation of unresolved issues and increased relationship tension. Therefore, the lack of effective conflict resolution

mechanisms is an important aspect of communication barriers among elderly couples.

Trust issues: Some elderly couples face trust issues, which may manifest as reluctance to seek help from a partner or doubts about the partner's honesty. This lack of trust may be related to past betrayals, poor communication, or misunderstandings about the partner's behavior, ultimately affecting the stability and intimacy of the relationship.

Differences in daily decision-making: Elderly couples often have differences in daily decision-making, especially regarding major family matters. These differences may stem from divergent values, expectations, or power dynamics, leading to more frequent conflicts or emotional distancing. As such, differences in daily decision-making are an important aspect of communication barriers among elderly couples.

3.3. Attitudes and Preferences of the Elderly in Using Intelligent Assistants

Elderly individuals' attitudes and preferences toward the use of intelligent assistants are influenced by their level of awareness of social robots, their acceptance of social robots, and their areas of interest regarding social robots. We conducted a survey focusing on these three influencing factors.



Fig 2. Investigation results of: a)Older couples' daily life issues, b)Older couples' intentions toward robots

Understanding Level of Social Robot: Our research shows that only 3.36% of elderly respondents are very familiar with home companion robots, while 41.18% have some understanding, and 26.05% have no understanding. This lack of familiarity could hinder widespread acceptance and use of such technologies among older adults.

Acceptance of Social Robot: Our research found that only 4.2% of elderly respondents had interacted with home companion robots, yet 52.1% expressed interest, and 18.49% were very willing to try robots for improving spousal communication. Despite some neutrality or indifference, the findings suggest a generally positive attitude, with many showing interest in robots, particularly for enhancing communication.

Interests in Social Robot: The data shows that elderly individuals prefer social robots for reminding important events (68.07%), coordinating household tasks (48.74%), and providing entertainment (47.9%). In communication between spouses, 56.3% want the robot to actively coordinate, 71.43% prefer it to offer advice, while 27.73% favor message relay. The findings highlight a strong preference for active roles like advice and coordination, though some also expect more passive functions such as being a neutral observer.

4. Design of Robot-Mediated Communication Strategies

4.1. Strategy Framework Based on the Communication Characteristics of the Elderly

In the subsequent section, our interviews focus on factors that may lead to conflict in elderly couples' daily lives and the communication strategies they use, addressing research questions RQ1 and RQ2. This study aims to provide insights for developing technology-mediated systems to enhance relationship maintenance, specifically exploring design opportunities for mediator robots in elderly couples' relationships.

From an initial sample of 119 elderly couples, 19 individuals (9 males, 10 females) were selected based on their use of positive and negative communication strategies and interest in mediator robot design. Participants were aged 62-80 (mean=67.1). Interviews were voluntary, recorded for internal use, and lasted about 40 minutes.

The data utilized in this study encompasses video recordings of interviews, as well as notes meticulously documented by researchers throughout the interviews. The analysis of this data was conducted through a semi-structured qualitative data analysis approach [7, 19, 28]. This analytical process was executed in two distinct phases. Initially, two authors independently engaged in a preliminary filtering of the content by reviewing the text data and visual recordings.

Concurrently, the authors tagged citations of interest with relevant keywords in a process referred to as open coding. In the subsequent phase, the authors collaborated to apply the nine dimensions outlined in the Interference Dimension Coding System (IDCS)in order to assess the dimensions of interaction between emotional responses (both negative and positive) and content-related factors (e.g., conflict, Mode of getting along and communication skills) pertaining to intimate relationships [24]. This involved revisiting the original text data, during which any redundant or irrelevant codes were discarded, and new insights, which arose from further deliberations, were incorporated into the open coding framework. Consequently, the analysis involving 19 participants yielded a total of 102 open codes, which were categorized into eight thematic topics. The results of this study are presented as follows.

Table 1. Demographics of older participants.

ID	Age/Gender	Communication strategy	Relationship evaluation
T1	72 M	Passive-aggressive(A4)	Normal
T2	70-80 F	Aggressive(A2)	Normal
T3	66 F	Assertive(A1)	Normal
T4	67 F	Passive(A3)	Dissatisfaction
T5	80 M	Assertive(A1)	Satisfaction
T6	63 F	Passive(A3)	Normal
T7	68 M	Assertive(A1)	Satisfaction
T8	62 F	Passive(A3)	Normal
T9	64 F	Assertive(A1)	Satisfaction
T10	63 F	Assertive(A1)	Satisfaction
T11	69 F	Passive-aggressive(A4)	Satisfaction
T12	62 F	Passive-aggressive(A4)	Dissatisfaction
T13	68 M	Passive-aggressive(A4)	Satisfaction
T14	66 F	Assertive(A1)	Satisfaction
T15	66 M	Passive-aggressive(A4)	Satisfaction
T16	67 M	Passive(A3)	Dissatisfaction
T17	71 M	Passive-aggressive(A4)	Normal
T18	62 M	Assertive(A1)	Satisfaction
T19	72 M	Passive-aggressive(A4)	Normal

Interviews revealed four communication styles that significantly impact relationship satisfaction in elderly couples: Assertive(A1), Aggressive(A2), Passive(A3), and Passive-aggressive(A4). Assertive communication fosters understanding and healthy dialogue, while aggressive communication leads to tension and conflict. Passive communicators may neglect their own needs, causing frustration, and passive-aggressive individuals express discontent indirectly, creating emotional distance.

When developing a communication strategy framework for elderly couples, we must first acknowledge that each couple's interaction is unique, influenced by a variety of factors such as their personal history, individual characteristics, psychological state, and external environment. As interviews have shown, the diversity of communication patterns—ranging from confident to aggressive, passive, and passive-aggressive—becomes especially pronounced in elderly couples' relationships. These patterns not only reflect personal traits but are also closely tied to their socio-economic background and social support networks. Furthermore, conflicts between couples are often not caused by a single factor, but rather result from the interplay of a complex set of internal and external influences.

In this context, creating an effective communication strategy framework requires recognizing the diversity and complexity of elderly couples' communication, as well as the specific challenges they face. Based on this, our communication strategy framework for elderly couples focuses on the following key aspects:

Elderly couples need to actively address communication issues: Although most participants (e.g., T11, T13, and T15) expressed subjective satisfaction with their current communication styles during interviews, they also acknowledged that there were problems, often manifesting as passive behavior. T5 recalled, “Knowing my partner’s personality, I usually choose to back down to avoid worsening the relationship.” This may be related to the concept of mutual respect in Chinese couples. Additionally, T5, T7, and T9-10 were highly satisfied with their communication styles, while T4, T12, and T16 expressed disappointment and a desire for strategies to maintain a positive relationship. Elderly couples should actively explore communication models that promote mutual understanding, avoiding negative or passive approaches.

Address communication between elderly couples by targeting both internal and external factors: The complexity of elderly couple relationships arises from the interaction of multiple internal and external factors. Internal factors, such as individual personality differences, mental health, and communication styles, directly affect partner satisfaction. At the same time, external factors, such as socio-economic status and social support, also significantly impact the health of elderly relationships. For example, T16 mentioned, “My partner’s dominant personality leads to emotional imbalance in communication.” T4 described a lack of communication topics due to differences in educational experiences with their partner during daily activities. These factors intertwine, presenting numerous challenges and complex relationship

dynamics for elderly couples. Moreover, internal factors contributing to disputes may indirectly affect external factors. Most participants (9 out of 19) reported that personality clashes or discordant expressions from older partners often triggered conflicts. For example, T6 stated, "My partner is too stubborn, and it's impossible to reason with him," which usually escalated into arguments. In contrast, participants with similar or compatible personalities (T5, T9, T14) found it easier to reach understanding during communication. Participants also reported that conflicts related to external factors primarily revolved around children's education (T4, T6, T11, T14, T19), household chores (T2, T5, T8, T13, T15, T17-18), family interference (T16), and social circles (T1, T7, T12). Notably, conflicts over shared household responsibilities were the most frequent, with T17 noting, "My partner and I have different attitudes toward household chores. We often express dissatisfaction, and after hearing it repeatedly, it leads to frustration and arguments." Improving communication quality between elderly couples requires addressing both internal and external dimensions. On the internal side, recognizing and respecting personality differences, enhancing mental health awareness, and improving communication methods—such as active listening and nonviolent communication techniques—are essential. On the external side, optimizing socio-economic conditions, strengthening social support networks, and encouraging couples to participate in shared activities can increase common topics and understanding. Implementing these strategies can promote effective communication between elderly couples and improve their relationship satisfaction.

Elderly couples need to actively face conflict issues: When facing conflict, rather than engaging in positive communication (A1), more participants (A3, A4) chose to ignore conflict issues with indifference or avoidance, thus avoiding direct confrontation to maintain relationship harmony. T12 mentioned that to prevent conflicts from escalating, "I just didn't talk to him, and there was hardly any communication." However, she also expressed a desire to improve the atmosphere between her and her partner and rebuild communication. In contrast, couples with better relationships (T5, T9, T14) usually resolved conflicts promptly through negotiation, preventing unresolved issues from affecting their relationship.

Elderly couples should participate in joint daily activities and hobbies: Our research found that participants who engaged in shared daily activities and hobbies exhibited more beneficial behaviors for maintaining their relationships. For example, T15 stated, "My wife and I often play chess or the piano together at home." These shared activities fostered communication between partners and helped maintain their relationship. In contrast, most participants (17 out of 19) reported a lack of shared entertainment with their partner at home, leading to insufficient emotional support. This indicates that participating in joint daily activities can enhance emotional intimacy between elderly couples by creating opportunities for interaction, thus strengthening their bond. Furthermore, effective communication and cooperation are crucial for elderly couples to maintain the quality of their relationship. Ultimately, the interaction between daily activities, supportive communication, and deliberate efforts to maintain the relationship significantly influences the resilience and satisfaction of elderly couples' relationships, thereby enhancing their overall quality of life and emotional well-being.

Third-party mediation: Our research found that participants mainly adopted two opposite strategies to resolve conflicts: active engagement and conflict avoidance. Some participants chose to directly express their opinions and actively communicate with their partners when resolving conflicts, while others tended to avoid conflicts by ignoring issues and hiding their thoughts. Among participants who actively engaged (A1), communication strategies included self-disclosure, listening, and empathy. In contrast, negative participants (A3, A4) exhibited communication strategies characterized by avoidance, emotional withdrawal, and emotional expression. T13 demonstrated a negative strategy of avoiding issues during conflicts, stating, "When they couldn't negotiate with their partner over ongoing issues, they still chose to continue avoiding them." Since couples often have different strategies and attitudes toward communication, this directly affects the quality of communication. We found that third parties play a regulatory role in the dynamics of elderly couple relationships, effectively alleviating communication problems caused by differences in communication styles. Participant T12 noted that when younger generations intervened in conflicts, communication strategies often changed. Specifically, "In front of grandchildren, the elderly tend to suppress their anger and resolve conflicts more peacefully." The involvement of younger family members can help ease tensions in such interactions and shift focus.

4.2. Optimization Suggestions for the Interaction Interface of Intelligent Assistant

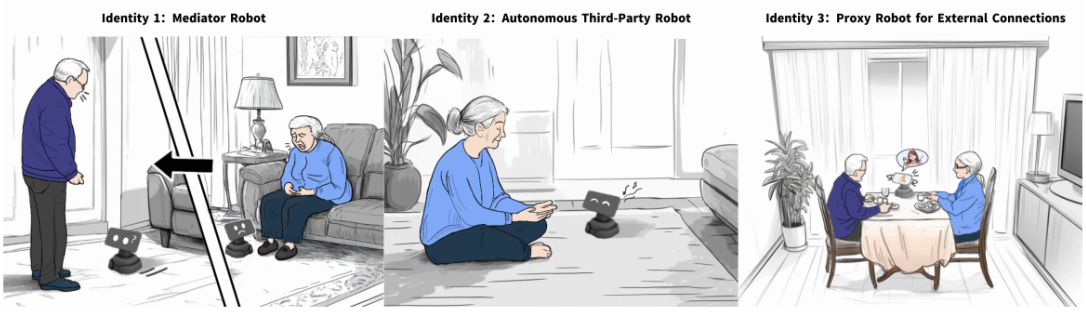


Fig 3. The picture on the left depicts a mediation robot assisting an elderly couple in conveying information during communication conflicts. The middle picture illustrates autonomous third-party robots accompanying the elderly, stepping in for the younger generation. The picture on the right presents a scenario where an external contact agent robot interacts with the elderly on behalf of their family members

The main text provides a detailed description of the specific role functions. Our interviews highlight the complexity of

communication among elderly couples, involving emotional expression, negotiation, and conflict management. Internal and external factors, like health and daily interactions, drive conflicts. Understanding these dynamics helps designers address relationship challenges more effectively. Positive communication strategies include emotional expression, active listening, and empathy. Third-party interventions also play a key role in resolving conflicts, underscoring the need for refined technical solutions.

We propose that intelligent assistants can serve as a bridge for intergenerational communication, mediating relationships within families and enhancing emotional connections between elderly couples and other family members. Through these functions, intelligent assistants can effectively support and improve communication and emotional management for elderly couples, thereby enhancing their relationship satisfaction and emotional well-being. Traditional social assistants, however, often lack the adaptive capacity to mediate such complex and emotional interactions. Therefore, we propose three different roles for mediating assistants as an optimized interaction scheme for intelligent assistants (Figure 3):

Mediation Assistant: In Scenario 1 of Figure 3, the mediation assistant acts as a neutral facilitator of communication, suitable for couples who struggle to express emotions directly or tend to avoid conflict. Acting as a "messenger," the mediation assistant can help reduce emotional tension and provide a clearer, more reinforced communication platform. The robot can also adapt to the communication pace and habits of elderly users, overcoming challenges such as hearing loss or memory decline.

Autonomous Third-Party Assistant: Reflecting the role of a third party in mediating conflict, this assistant operates independently, guiding each partner separately through conflict resolution and suggesting empathy-driven responses while mediating intense conversations. In Scenario 2 of Figure 3, it also provides emotional support and companionship when one partner of the elderly couple lives alone.

External Contact Proxy Assistant: This robot can act on behalf of external family members or healthcare providers during the communication process. It can seek external support and advice when necessary, offering diversified solutions. This type of robot has been widely applied in telepresence and healthcare settings, representing absent individuals and providing a sense of connection while also assisting in decision-making. In Scenario 3 of Figure 3, the external contact proxy assistant interacts on behalf of family members with the elderly, effectively reducing the sense of loneliness experienced by seniors when their children are unable to accompany them in person.

Each role has unique functions, and design guidelines include creating familiar, user-friendly interactions. The appearance of mediating robots is vital for users' first impressions and directly influences how elderly individuals communicate with them. Humanoid and pet robots are preferred due to their strong affinity, encouraging more open expression[17]. Ideally, the robot should be small or medium-sized to fit in living rooms and studies, where larger robots may hinder mobility[53].Voice interaction is preferred by most elderly users, though concerns about unclear speech need to be addressed with adaptive voice recognition[38]. Additionally, smart assistants should feature diverse actions and expressions to reduce social distance and encourage interaction. The ability to seamlessly switch between mediator, third-party, and proxy roles is essential for offering appropriate support in various scenarios.

4.3. Effectiveness Evaluation of Communication Strategy Implementation

A third-party smart assistant can significantly improve communication quality in elderly couples by offering emotional support, aiding communication, and coordinating daily activities. The assistant helps overcome communication barriers by facilitating joint activities that enhance emotional connection and providing real-time feedback to help couples understand each other's emotions and needs. Additionally, by monitoring social interactions and emotional changes, the assistant delivers personalized communication advice and psychological support, boosting relationship satisfaction and overall quality of life while mitigating issues caused by differences in communication styles.

5. Empirical Research on Intelligent Assistant Intervention in Communication

5.1. Research Methods and Data Collection

This study aims to address RQ3 with the following objectives: 1) to develop a comprehensive understanding of elderly individuals' views and preferences regarding social robots, and 2) to evaluate the feasibility of the three robot identities introduced during the interview phase and undertake a complete design process for them.

By actively involving stakeholders in the design process, this study ensures that intelligent assistant strategies are more closely aligned with their diverse needs, goals, and expectations. With advancements in AI, integrating AI into participatory design can significantly reduce barriers[42]. The participants from the previous section were invited to this study, ensuring that design decisions for the intelligent assistant would specifically address users' actual needs and issues.

The study is divided into three phases:

1) The first phase focuses on the three robot identities. Researchers presented pre-made videos demonstrating each robot's functions, allowing participants to quickly understand their capabilities. After the video presentations, participants discussed and evaluated each identity based on their experiences.

2) The second phase centers on the appearance and behavior of the robots. Researchers pre-screened 44 intelligent assistant cases in different groups, evaluating them based on five dimensions: shape, size, display, interaction method, and behavior. After watching the cases, participants discussed them and chose their preferred designs.

3) In the third phase, participants designed social intelligent assistants and their application scenarios based on their understanding. With researchers' assistance, participants used AIGC technology to generate images of these designs.

During the participatory design process, we collected diverse qualitative data (Figure 5). All discussions were audio-recorded and transcribed verbatim. In addition, we meticulously documented the text descriptions provided by participants for image generation, along with the content of the generated images.



Fig 4. Participatory design is divided into three phases: Phase 1— robot identities understanding; Phase 2— robot cases evaluation; Phase 3—social robot design

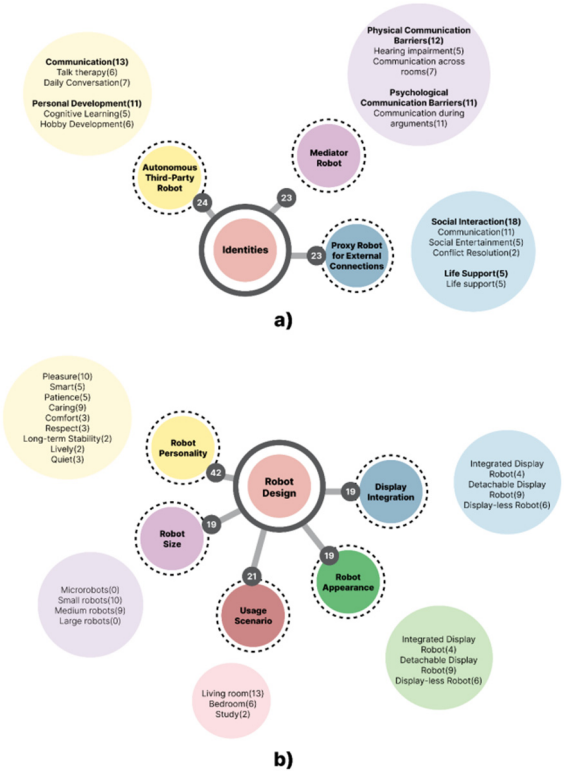


Fig 5. Investigation results of: a)Visual guide of each identities of mediator robots from participatory design, b)The perceptions of the elderly toward robots

5.2. Case Analysis: Application of Intelligent Assistants Among the Elderly

Intelligent assistants effectively enhance communication quality among elderly couples by providing emotional support, facilitating communication, and coordinating daily activities. Research indicates that the application prospects of smart assistants in the communication of elderly couples are broad. About 89% of participants prefer designs that are simple and intuitive, while 84% find voice interaction to be the most convenient, reducing the complexity of operations and enhancing user comfort.

Additionally, linking the design of smart assistants to familiar objects for the elderly helps improve their acceptance. Many elderly individuals favor friendly and approachable designs, with 42% preferring humanoid robots and 31% favoring pet-like robots, as they believe these designs convey warmth and companionship. This design concept can significantly enhance elderly individuals' acceptance of robots and improve their overall quality of life.

The application of intelligent assistants in elderly couples' communication covers several roles, each with unique functions and advantages:

Mediator Role: In cases of marital conflict, intelligent assistants can effectively convey both parties' thoughts, helping to prevent emotional escalation and promote understanding and conflict resolution. 58% of participants expressed a desire to use intelligent assistants to relay opinions during arguments, allowing them to express their views more rationally and avoid hurtful language triggered by impulsive emotions. Additionally, intelligent assistants can serve as communication bridges during periods of silence, providing both partners with time for reflection and facilitating deeper mutual understanding.

Autonomous Third-Party Role: Intelligent assistants not only provide companionship to alleviate loneliness but also guide conversations and shared interests, helping elderly couples maintain emotional connections and common hobbies. For instance, they can remind couples to listen to music or share life moments together, enhancing their interactions and emotional bonding. Furthermore, intelligent assistants can support users in maintaining a positive mental state by offering companionship and conversation, especially when they feel lonely or depressed, thus alleviating emotional distress.

Proxy Role: Intelligent assistants can also act as proxies for external family members or healthcare providers, facilitating remote communication and care. They enable voice and video

interactions between family members, reducing communication barriers caused by distance. 73% of participants believe that intelligent assistants help strengthen connections with distant relatives, allowing them to participate in synchronous activities, such as remote exercises or video calls, thereby deepening familial bonds. Additionally, intelligent assistants can introduce third-party mediators, such as children or friends, during marital disputes, offering new solutions to avoid conflict escalation.

5.3. Empirical Results and Discussion

Empirical evidence shows that social robots with a pleasant personality are the most popular among elderly users, as they provide emotional support and enjoyable interactions. In the text coding of AIGC-generated images, the term "pleasant" appeared most frequently, reflecting its importance. Analysis of AI-generated images indicates that these robots display their characteristics through intimate communication (Figure 6), effectively reducing the psychological distance with users and enhancing their sense of pleasure.



Fig 6. Analysis of AI-generated images featuring the word “pleasant” reveals that they often showcase the characteristic of close interactions between robots and older adults. The images marked with an asterisk are those that users believe best match the text descriptions they have written

Further research reveals that facial expressions and movements play a key role in conveying a sense of joy. Robots with expressive faces or humorous, clumsy movements often trigger laughter and positive emotions, enhancing user happiness and improving social interaction and mental health. Thus, designing joyful social robots should focus on enhancing interactive experiences and emotional expression to meet elderly users' needs. Robots with a caring personality are equally popular. In the analysis of AIGC-generated images, "caring" was the second most common trait, reflecting the elderly's need for companionship. These robots convey care through face-to-face communication, regardless of appearance or background (Figure 7).



Fig 7. Analysis of AI-generated images featuring the word “caring” reveals that they typically showcase the characteristic of face-to-face communication between robots and older adults. The images marked with an asterisk are those that users believe best match the text descriptions they have written

Face-to-face interaction significantly enhances the ability to communicate emotionally between humans and machines. This direct form of communication facilitates relationship building and makes participants feel more valued and understood. Additionally, face-to-face communication supports a broader range of emotional expressions. Non-verbal communication modes, such as body language, facial expressions, and tone of voice, are fully realized in this type of interaction, allowing emotions and attitudes to be conveyed more effectively.

6. Challenges and Prospects of Intelligent Assistant Intervention in Communication

6.1. Technical Challenges and Solutions

Due to the complexity of communication among elderly couples, two main strategies emerge: active participation and conflict avoidance. These present significant technical challenges for smart assistants, requiring an understanding of multi-layered emotional expressions and relationship dynamics. Our findings show that enhancing emotional connection through communication strategies can significantly strengthen relationships.

Previous research suggests that third-party interventions can help couples reflect on their behavior during conflicts, increasing emotional awareness and fostering constructive communication. Many participants expressed a need for mediator robots to generate conversation topics to address a lack of shared activities, which weakens emotional bonds. Robots could facilitate communication by introducing activities or topics to enhance emotional connection and satisfaction.

Design guidelines for social robots emphasize the importance of appearance, interaction style, and adaptability. Human-like and pet-like robots with small or medium sizes are preferred to ensure ease of interaction in common household spaces. Voice interaction is favored by most elderly users, though concerns about voice clarity necessitate robust speech recognition systems that accommodate various pronunciations and speeds. Additionally, robots that exhibit diverse actions and expressions can reduce social distance and encourage engagement.

Technically, robots must switch roles seamlessly—acting as a mediator in daily conversations, an autonomous third-party during conflicts, and a proxy for family members when necessary. This adaptability is essential for providing the appropriate support in different social situations, ensuring smooth transitions between these roles based on the needs of elderly couples.

6.2. Impact of Cultural Differences on Intelligent Assistant Intervention

Our study is context-specific, influenced by Confucian values of family harmony and emotional restraint in Chinese culture. Participants often handled conflicts subtly, avoiding direct confrontation, which may lead to emotional buildup. These findings suggest that different cultures may have unique communication styles, with avoidance being a common strategy.

Cross-cultural research is needed to explore how cultural values shape communication. Understanding these differences can help tailor intelligent assistant interactions, making technological interventions more effective and culturally appropriate.

6.3. Future Research Directions and Prospects

Our study has limitations, including participants' limited understanding of intelligent assistant and the absence of prototype evaluations, which restricted authentic feedback. Researchers also lacked strategies to elicit specific communication scenarios. Future studies should adopt scenario-based design to better engage participants.

Key findings revealed valuable insights but raised questions, such as when intelligent assistant should switch roles and whether interventions should be user- or robot-initiated. Future intelligent assistant must act as intelligent mediators in complex marital communication, leveraging situational awareness to improve conflict resolution. Even basic robots, by integrating communication strategies, can positively influence elderly couples' interactions.

7. Conclusion

7.1. Research Summary and Findings

As elderly couples face challenges such as physical and cognitive decline, the quality of daily communication becomes a key factor in their subjective well-being. This study provides a detailed qualitative analysis of communication dynamics among elderly couples, highlighting the role of intelligent assistant in enhancing communication, maintaining relationships, and improving overall life quality and emotional well-being. The findings offer valuable insights into how intelligent assistant can act as facilitators for couples who are emotionally distant yet seek connection, informing future research on technological interventions aimed at promoting elderly well-being.

7.2. Recommendations for Future Research

For the future design of intelligent assistant, we advocate starting small, focusing on specific communication scenarios among elderly couples, and using clever design to act as a catalyst and bonding agent, rather than replacing third-party users. This paper calls for more empirical research and systematic attention to explore the cognitive, emotional, psychological, and behavioral impacts of intelligent assistant on elderly couples, ensuring that future social robots can better integrate into the dynamic environment of human social interactions.

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