The Influence of Acquaintanceship on Co-Presence and Closeness in Robot-Mediated Communication with Older Adults

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***Abstract*— Family and friends (strong interpersonal relationships) are crucial for a person's well-being. However, geographical distances often hinder staying in touch, especially for older adults. Telepresence robots can support strengthening these interpersonal relationships and enhance communication. We aim to investigate how the strength of the interpersonal relationships (i.e., interacting with family or friends vs. an acquaintance) and the impact of using gestures (as opposed to not using them) can influence co-presence, closeness, and effectiveness in Robot-Mediated Communication (RMC). For that, we carried out an experiment with 24 older adults (living in Germany) where they used a telepresence robot to perform a collaborative communication task. Our findings show that older adults report higher co-presence and closeness in RMC when interacting with family or friends compared to interactions with acquaintances, while communication effectiveness was not affected by the relationship strength. Additionally, negative assumptions about robots may influence how telepresence is experienced.**

I. Introduction

Older adults tend to have smaller social circles than other age groups, but still view social relationships as highly important [1]. Interpersonal relationships (social ties), specifically, mostly strong ties (e.g., family and friends) contribute to a person's social well-being [2]. However, maintaining these interpersonal relationships can be challenging when they are geographically distant, especially for older adults. While phone calls and videoconferencing allow for communication, telepresence robots (mobile robots with video conferencing capabilities) or Robot-Mediated Communication (RMC) promise to enhance communication by providing physical embodiment to remote communication partners, allowing for apparent agency [3], co-presence [4], [5], [6], [7], and could potentially strengthen these interpersonal relationships.

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The main goal of telepresence robots and RMC is to enhance social interaction [8]. Allowing a telepresence robot to identify, react, and execute gestures can enhance communication. For instance, Cabibihan et al. [9] found that adding gestures during RMC aids recalling when compared to only videoconferencing. Conde et al. [10] found that older adults are interested in using gestures to interact with the robot during RMC. However, how older adults actually perceive gestures for control during RMC is yet to be explored.

Our research questions focus on (RQ1) how interpersonal relationships affect, and (RQ2) what is the influence of using gestures on perceived co-presence, closeness, and communication effectiveness. To find answers to those questions, we carried out a study with 24 older adults, where they engaged in a collaborative communication task using a telepresence robot. Our main contributions and findings are: (1) an empirical study that demonstrates that co-presence and closeness is higher when communicating with family/friends compared to an acquaintance in RMC with older adults, but does not affect communication effectiveness; (2) the use of gestures (for robot control) in RMC may not always enhance the communication experience; and (3) negative preconceptions of robots can influence how telepresence is experienced.

II. Related Work

A. Telepresence Robots and Older Adults

For older adults, telepresence and social robots can be used to promote healthy aging and social well-being [11]. Moyle et al. [12] reported that people living with dementia perceived social presence and emotional closeness using telepresence robots with their caregivers. Telepresence robots can also contribute to maintaining social contacts with family and friends when living in an assisted living facility [13]. Also, Wengefeld et al. [14] evaluated the use of a telepresence robot with older adults in a long-term study and found that one of the factors contributing to the positive evaluation of the robot was improving their social connection.

When using telepresence robots with older adults, aspects such as control and gestures can foster the willingness to use telepresence robots. For instance, Conde et al. [6] found that local control can support autonomy and reduce passivity in RMC with healthy older adults. They also found that gesture interaction, especially allowing a robot to perform deictic gestures, is a desired feature of telepresence robots [10]. Cortellesa et al. [15] presented a telepresence robot with gesture and voice recognition capabilities, where older adults highlighted its usability. However, they found that the older adults' personality, especially openness to experience, is a determining factor on robot's acceptance. Similarly, Arevalo Arboleda et al. [16] identified that some older adults may not be willing to accept or use telepresence robots.

B. Presence, Closeness, and interpersonal relationships in Mediated-Communication

Interpersonal relationships can moderate the way communication is perceived. Fernandez et al. [17] argued that the perceived quality gap between Face-to-Face (FtF) and mediated communication is likely larger for acquaintances than for close partners, as weaker relational depth provides less support for interpreting limited cues. Similarly, Kroencke et al. [18] reported lower well-being after interactions with weak ties than with close peers, with a larger close–weak-tie difference in FtF than in computer-mediated contexts.

One of the commonly studied aspects of mediated communication is social presence. Short et al. [19] define social presence as "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationship." This early definition of social presence mentions the interpersonal relationship as a factor within social presence. Other definitions dissect social presence and mention co-presence as an aspect of social presence that involves the feeling of being "in the company of others" in mediated communication [20] and consider the individual perception of the mediated others that can change during interactions [21]. These concepts mention the critical role of the communication partner and their interpersonal relationship in the formation of social presence.

Closeness can be conceptualized as a "relational state that takes place and dissipates within an interaction" [22]. Gooch et al. [23] found that using videoconferencing and FtF interactions with family and friends evokes higher levels of social presence and closeness compared to phone calls, messages, and social networks. In a later study, they found that the medium used has a lower impact on reported social presence and closeness when interacting with family and friends compared to the context that surrounds the interpersonal relationship, e.g., the frequency of communication [22].

These previous findings present the relevance of the communication partner in mediated communication for social presence and closeness. However, it remains unknown how mediated communication influences the perceived co-presence and closeness of individuals with different interpersonal relationships' strength.

III. Method

We present a 2×2 within-participants study to investigate the influence of the strength of interpersonal relationship with the communication partner (familiar or acquaintance) and the use of gesture recognition (enabled or disabled) on collaborative communication using a telepresence robot. The gestures we used were: raise the arm to start/answer a call, cross the arms in front of the chest to end a call, and the projector would emit a light to a pointed area when the participant (co-located with the robot) performs a deictic gesture, see Figure 1. To represent an acquaintance, one of the experimenters acted as a confederate.

(a) Pointing (b) Start Call (c) End Call

Fig. 1: Participant co-located with the robot using gestures to (a) point and the robot highlights the pointed area, (b) raises the arm to start a call/answer a call, (c) end the call.

A. Measures

We collected subjective self-reported measures of co-presence, closeness, and objective communication effectiveness. Additionally, we conducted a short final interview.

For co-presence, we used the questionnaire from Biocca et al. [24] (6 questions, 7-point Likert scale from "1-Strongly Disagree" to "7-Strongly Agree"). Participants replied to this questionnaire twice, once to determine the level of co-presence of the conversational partner and a second time to determine the co-presence of the telepresence robot itself. Our goal was to better understand whether participants rate the level of co-presence differently when we explicitly ask about the robot or the human displayed on the screen of the telepresence robot. For closeness, we used the Inclusion of Others in the Self (IOS) questionnaire, similar to [25], [5], using a pictorial representation of the self and the other on a 1-7 scale ("1-no overlap", "2-little overlap", "3-some overlap", "4-equal overlap", "5-strong overlap", "6-very strong overlap", "7-most overlap"). To determine communication effectiveness, we considered the number of correct responses during our referential communication task as an objective measure. In the short interview we asked: (Q1) Can you describe your experience? What did you like or did not like? (Q2) Do you think that the gestures and the robot's interpretation of them were appropriate for the context? why? (Q3) During RMC, did you consider the robot and the person as 2 separate entities? Or as one? and why?

Before starting the experimental task, we collected information about the subjective attitude towards robots using the General Attitudes Towards Robots Scale (GAToRS) [26], which has four dimensions: Personal Level Positive (P+), Personal Level Negative (P−), Societal Level Positive (S+), and Societal Level Negative (S−).

B. Task and Procedure

We used a collaborative communication task grounded in referential communication, which requires establishing a common understanding during conversations [27], [28]. This task aimed at creating a similar scenario where someone remotely located provides support by describing household items that cannot be easily seen or found. For that, we used Tangrams (polygons that form shapes) [29], a common task used for referential communication and previously used in other similar studies [5], [28]. In this type of communication task, each conversational partner has a role as a "director" or "matcher." Directors, remote participants, provide verbal descriptions, while matchers (local participants co-located with the robot) listen to the description and point at the image (tangram) that they consider the director is referring to.

The task was to either act as a director or a matcher (participants acted as both, taking turns with the conversational partner). During the task, the robot follows the local person, and either displays a pointing light towards the pointed area when the participant performs a deictic gesture, or just moves the camera to have the arm of the person in view.

We displayed 27 tangrams around a Living Lab. The lab is designed to represent a living room and has furniture, shelves, ornaments, TV, etc, as seen in Figure 1. The matcher walked around the room looking for the image that would match the description of the director. We instructed participants to give further descriptions if the matcher did not guess the tangram right the first time. The task lasted 3 minutes.

In the experimental procedure: (1) We gave a short introduction about the experiment, the devices, the experimental flow and task. (2) One participant stayed in the room where the robot was located (matcher), and the other participant (director) moved to a different room. We informed them that they would later switch roles. The matcher signed a consent form and filled out a demographic questionnaire about previous experiences with robots and general perception of robotic systems. (4) They performed the experimental task. (5) The matcher filled out questionnaires related to their experience and had a short interview. (6) Participants switched roles. The experiment lasted approximately 60 minutes

C. Quantitative and Qualitative analysis

We analyzed the questionnaire data using Aligned Rank Transform (ART) [30] as our data was not normally distributed, assessed by visual inspection using QQ-plots and Shapiro-Wilk tests. When significant differences were detected, we calculated post-hoc pairwise comparisons using ART-C and Bonferroni correction.

The interview data were analyzed using a reflexive Thematic Analysis (TA) approach (a single researcher engages thoughtfully with the data) following Braun & Clark guidelines [31] and QualCoder [1]. We followed an inductive process with a focus on broad patterns that emerge from participants' answers to Q1 and Q3 (related to RQ1), and Q2 to gain insights on RQ2. The main author read the answers for familiarisation. Then, the data was re-read to generate initial codes. Next, the data and codes were re-read, leading to the rephrasing of some codes. These codes were sorted and grouped to generate initial themes. The initial themes were then revised to refine them and provide the final themes.

[1]https://qualcoder.wordpress.com/

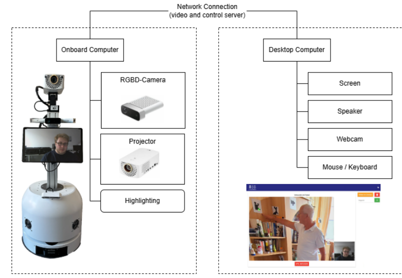

Fig. 2: Overview of the system architecture

D. Participants

We recruited 24 older adults with no physical or cognitive disabilities (M = 72.75, SD = 3.87), distributed in 17 females and 7 males, with an age range from 66–81 years old. Nine participants had previous experience with the telepresence robot used in the experiment. The GAToRS scale [26] revealed at a personal level, a rather positive attitude towards telepresence robots at a personal level (P+, M = 4.94, SD = .97, Cronbach's alpha = .62), and disagreement with negative attitudes (P−, M = 2.98, SD = 1.5, Cronbach's alpha = .82). At a societal level, a very positive attitude towards robots (S+, M = 6.32, SD = 1.19, Cronbach's alpha = .91) and agreed with negative attitudes of robots (S−, M = 4.74, SD = .92, Cronbach's alpha = .36). We call for a note of caution on our results of GAToRS P+ and S−, as the reliability test showed questionable to unacceptable reliability.

Participants were recruited through a mailing list of participants who had taken part in similar technology-related studies. Participants were asked to attend the experiment with a family member or a friend. Participation was voluntary without any monetary compensation. This study was pre-approved by the university ethics committee.

E. Apparatus

The mobile robot used in this study is based on a MetraLabs TORY[2], extended with additional sensing and projection capabilities as described in [32]. The platform was equipped with a Microsoft Azure Kinect[3] for video capture and a Rode Wireless GO II microphone for audio transmission. A projector[4] mounted on a pan-tilt unit enabled spatial highlighting of the tangrams in response to participants' pointing gestures. Figure 2 shows the system architecture.

Video-based communication was realized using a browser-based interface built on WebRTC, providing standard video call functionality (e.g., accept and end call). The remote participant (director) used a desktop PC equipped with a Logitech Brio Stream[5] webcam for audiovisual interaction. Robot navigation and projection control were implemented

[2]https://www.metralabs.com/de/tory-rfid-inventurroboter/, Last accessed: 24. February 2026

[3]https://azure.microsoft.com/en-us/products/kinect-dk/, Last accessed: 24. February 2026

[4]https://www.lg.com/de/beamer/portable-und-lifestyle-projektoren/hf60ls/, Last accessed: 24. February 2026

[5]https://www.logitech.com/en-us/products/webcams/4kprowebcam.960-001390.html, Last accessed: 24. February 2026

using a Wizard-of-Oz approach to ensure consistent behavior across experimental conditions.

IV. Results

A. Co-Presence

We evaluated the perceived co-presence of the communication partner and the robot separately and against each other. Regarding the communication partner, our results show significant differences for the interpersonal relationship ($F(1,69) = 8.91$, $p = .003$, $\eta_p^2 = .11$), where having a family/friend as communication partner led to higher perceived co-presence (M = 6.83, SD = .39) compared to an acquaintance (M = 6.65, SD = .49) in collaborative communication using a telepresence robot.

We did not find a significant effect of use of gestures ($F(1, 69) = 2.11$, $p = .15$, $\eta_p^2 = .02$) or a two-way interaction effect ($F(1, 69) = 1.73$, $p = .19$, $\eta_p^2 = .02$).

With respect to the telepresence robot, we did not find any significant difference in the interpersonal relationship ($F(1,69) = .02$, $p = .86$, $\eta_p^2 < .001$), the use of gestures ($F(1,69) = .57$, $p = .45$, $\eta_p^2 < .001$), or a two-way interaction effect ($F(1,69) = 1.08$, $p = .30$, $\eta_p^2 = .01$).

When comparing the reported co-presence of the communication partner with that of the robot ($F(1, 167) = 37.63$, $p < .001$, $\eta_p^2 = .18$), we found that the communication partner's reported co-presence (M = 6.74, SD = .45) was significantly higher than the robot's (M = 6.36, SD = .74).

B. Closeness

We found a significant main effect of the interpersonal relationship ($F(1,69) = 7.80$, $p = .006$, $\eta_p^2 = .10$) on perceived closeness. Participants reported higher perceived closeness in a collaborative communication task using a telepresence robot with family/friends (M = 4.92, SD = 1.38) than with an acquaintance (M = 4.04, SD = 1.74).

There was no significant effect of use of gestures ($F(1, 69) = .55$, $p = .46$, $\eta_p^2 = .007$) or a two-way interaction effect ($F(1, 69) = 2.20$, $p = .14$, $\eta_p^2 = .03$).

C. Communication Effectiveness

We did not find any significant difference of communication effectiveness (measured by the number of guesses) in the interpersonal relationship ($F(1,69) = .34$, $p = .55$, $\eta_p^2 = .004$), the use of gestures ($F(1,69) = .98$, $p = .33$, $\eta_p^2 = .01$), or a two-way interaction effect ($F(1,69) = 0$, $p = 1$, $\eta_p^2 = 0$).

D. Thematic Analysis

Participants' comments revealed not only the current perceptions of the telepresence robot and RMC but also future expectations. We present the GAToRs score next to participants' quotes to provide context for their current reported attitudes towards robots. Our analysis led to five themes:

- Preferences in robot control;
- The robot follows me, and I like that;
- The robot's reaction time to my actions is important;
- I would like the robot to do something more;
- Combined vs. separated entities during RMC.

1) Preferences in robot control: This theme includes aspects where participants noted the robot as "easy to control" and appreciated having various options for controlling it. For instance, P1 (GAToRS: P+ = 4.5, P– = 1, S+ = 6.5, S– = 6.0) mentioned, "I think it's good when you can control it with gestures like that and that you don't always have to press buttons." However, other participants mentioned preferring button presses for robot control. P13 (GAToRS: P+ = 3.5, P– = 4.5, S+ = 6.5, S– = 4.0) added, "I think gestures are a simplification. I also like to use the buttons, because gestures can be misinterpreted, but the button is unambiguous." Regarding controlling the robot, most participants mentioned ease, e.g., P6 (GAToRS: P+ = 3, P– = 1.5, S+ = 6, S– = 6) said, "The robot is easy to control."

2) The robot follows me, and I liked that: In this theme participants highlighted the "following behavior" of the telepresence robot. Most participants related it to the robot's movement behind the person. For example, P9 (GAToRS: P+ = 3, P– = 2, S+ = 6.5, S– = 4) said, "The robot followed me unobstrusively and observed my movements carefully," P17 (GAToRS: P+ = 5.5, P– = 7, S+ = 7, S– = 5.5), added details about the robot movements, "It is good that he orients himself toward the person and turns, moves forward or backward to perceive the environment." Some participants associated the robot's highlighting behavior and the "following behavior." P24 (GAToRS: P+ = 6, P– = 2.5, S+ = 6, S– = 4.5) mentioned, "It did not only follow me, but it also followed my gestures," P16 (GAToRS: P+ = 7, P– = 4, S+ = 7, S– = 5) explained, "I liked that I pointed at an image and the robot was able to find exactly what I pointed at. I thought that was great. It wasn't complicated; it came right over and highlighted the image."

3) The robot's reaction time to my actions is important: In this theme, participants mentioned aspects related to the actions that they performed and the robot's reaction time. Some participants mentioned that the robot had a good reaction time. P24 (GAToRS: P+ = 6, P– = 2.5, S+ = 6, S– = 4.5) expressed, "It reacted immediately to my gestures," similarly, P19 said, "when I pointed at a figure, it reacted quickly." However, other participants expressed that the robot reacted slowly to their actions, e.g., P6 (GAToRS: P+ = 3, P– = 1.5, S+ = 6, S– = 6) mentioned, "It was a little bit unfortunate that the robot needed some time to react." P10 (GAToRS: P+ = 4, P– = 4, S+ = 6.5, S– = 5.5) added, "It was a little bit slow." This shows the relevance of the robot's reaction time and highlights different paces of walking and performing actions of older adults.

4) I would like the robot to do something more: We used a telepresence robot, which has limited morphology and capabilities, as its main goal is to allow for embodied mediated communication. However, participants mentioned a desire for the robot to go beyond mediated communication. For example, P4 (GAToRS: P+ = 5.5, P– = 1, S+ = 1, S– = 5.5) mentioned, "I would like to ask it to do things like, Hey! Come here, or go out. I used to have a dog, I'd like to command it like a dog," P21 (GAToRS: P+ = 3.5, P– = 1, S+ = 6.5, S– = 3.5) also commented, "It would be great, if

I could also talk to it, so we could have a conversation," P11 (GAToRS: P+ = 4.5, P– = 3.5, S+ = 6, S– = 3.5) said, "I thought that the robot itself would do something, for example, if I say cup, that the robot would point at a cup." This emphasizes a desire for robots to act as a multifaceted entity that not only is capable of one single action but is also able to socialize and execute commands.

5) Combined vs. separated entities during RMC: This theme is grounded on Q2, where 14 participants mentioned that they consider the robot as one entity, e.g., P7 (GAToRS: P+ = 6.5, P– = 1, S+ = 6.5, S– = 5) commented "So, the robot wasn't separated from my conversation partner. In my mind, I think my conversation partner is standing next to me." While 10 participants mentioned that they are two separate entities, e.g, P8 (GAToRS: P+ = 4.5, P– = 4.5, S+ = 6.5, S– = 5) explained, "they are two separate entities. One is the person talking to me, and I am talking to him, and another is the robot that I command; I tell it, come with me, look here, look there." Here, some participants emphasized that the robot is a medium to talk to the other person, e.g., P17 (GAToRS: P+ = 5.5, P– = 7, S+ = 7, S– = 5.5) expressed "the robot acts as an intermediary, which is needed when both people are not in the same place," This shows that the physical embodiment capabilities that a telepresence robot offers may not always lead to a blend as one entity.

V. Discussion

A. The influence of interpersonal relationships

Co-presence and closeness involve interpersonal relationships that have often been ignored when evaluating mediated communication. Many studies that investigate social presence, co-presence, or closeness often do not consider the interpersonal relationship of a dyad (who are often acquaintances or strangers) [6], [5], [12] and how that affects the mediated interaction. We explored exactly that, with findings pointing to the influence of the strength of interpersonal relationships on co-presence and closeness, but not on communication effectiveness for older adults in RMC.

Although we focused on older adults in RMC, studies with younger populations have found that perceived communication quality and well-being are higher for close peers than for acquaintances and strangers in mediated communication [17], [18]. Our findings align with that and suggest that for older adults in RMC, their interpersonal relationship with their communication partner matters. However, contextual aspects of mediated communication, such as communication frequency can affect perceived social presence and closeness [22]. Investigating how closeness and co-presence in RMC and other type of mediated communication evolve over time becomes crucial to understand how it can support interpersonal relationships.

B. Rethinking RMC with older adults

Our findings did not show any influence of the use of gestures to control a telepresence robot during communication on our collected measures. Thus, we took a closer look at the results of our TA, which allowed us to contextualize the self-reported measures. Our TA revealed that participants appreciated using gestures for robot control, but some preferred using buttons on the screen. We consider that the manner in which we operationalized gestures and the type of measures collected (focused on co-presence and closeness) could have led to these results, i.e., gestures for starting/ending a call and a light to accompany deictic gestures. These rather basic gestures resulted from a co-design workshop of telepresence robots with older adults [10].

We also found that some features of the robot were emphasized, such as the following behavior and their reaction time, which should be tailored to the needs of each older adult, as mentioned in [33]. Moreover, participants expressed a desire for features that go beyond communication, such as being able to have a direct conversation with the robot.

C. The conversation partner and the robot in RMC

We took a closer look at the participants who perceived the remote communication partner and the robot as two entities (10/24). We found that the communication partner evoked higher co-presence compared to the one evoked by the physical robot, hinting that participants separated them as two entities with individual affordances. Further, the participants who considered them two entities had consistently reported a higher negative attitude towards robots (GAToRs P–) at a personal level compared to the mean of all participants. We encourage further investigation into the influence of negative preconceptions of robots and personality in RMC and HRI.

VI. Limitations

Our findings are limited by the experimental task, i.e., our task involved a specific communication structure which may be artificial. Some participants had previous experiences with this specific robot, which may have influenced their responses in co-presence and closeness. Still, technology exposure and familiarization have been deemed as crucial for robot and overall technology acceptance [34].

These findings represent the views of a specific demographic group, i.e., older adults living independently in Germany who are educated with no physical or cognitive disability. Also, we acknowledge that the genders in our sample are not balanced, as most self-identified as females, which could have influenced these results. We chose a confederate to represent an acquaintance; however, due to the broad definition of acquaintance (anywhere between stranger and at the edge of close ties [35]), interacting with an acquaintance that falls closer to the edge of close ties could lead to different results.

VII. Conclusion

We present a study to explore the influence of the strength of interpersonal relationships and the use of gestures in RMC with older adults. Participants engaged in a collaborative communication task with a family member/friend and stranger using a telepresence robot. Our findings show that in RMC, interacting with family/friends leads to higher perceived co-presence and closeness compared to interacting with strangers. We did not find any influence of the use of gestures for control on the communication experience, which could stem from the way in which we operationalized gestures. Also, we challenge the perception of RMC and telepresence, where the robot and the human would be perceived as one entity for the remote communication partner. Here, factors such as negative preconceptions of robots can influence this separation of the robot and the human in RMC.

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