I enjoyed the chance to meet you and I will always remember you: Healthy Older Adults' Conversations with Misty the Robot

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***Abstract*—** We conducted a 2x2 Wizard of Oz between-subject user study with sixteen healthy older adults. We investigated how to make social robots converse more naturally and reciprocally through unstructured conversation. We varied the level of interaction by changing the level of verbal and nonverbal communication the robot provided. Participants interacted with the robot for eight sessions engaging in an unstructured conversation. These conversations lasted thirty minutes to an hour. This paper will evaluate four questions from the post-interaction survey individuals completed after each session with the robot. The questions include: (i) I had fun talking to the robot; (ii) I felt I had a meaningful conversation; (iii) I was engaged the whole interaction; and (iv) I would consider the robot my friend. All participants reported they were engaged, had a meaningful conversation, and had fun during all eight sessions. Seven individuals felt the robot was their friend.

***Keywords*—** *User Studies, user centered design, human robot interaction, social robots, verbal, nonverbal, healthy older adults*

I. Introduction

As society continues to age, it will be essential to develop technology that can age with the individual. Smart home technologies seek to allow individuals to stay inside their homes for as long as possible; yet little work looks at how we can use technology in different life stages. Our work attempts to answer this question within the field of social robotics by investigating how to make conversational robots more natural and reciprocal.

Isolation can be anywhere an individual decides to age [1]. Often, people are not prepared for spending their remaining days outside of their home. Additionally, much work in social robotics for older adults focuses on people living with dementia and not healthy older adults. If people are familiar with technology before their mental cognition declines, it may be better positioned to help them. This initial contact with a social robot before the decline may be essential for the long-term adoption of a robot companion. It would allow for a familiar friend as people begin to move and age in different locations than their home and provide a sense of comfortability in uncertain times.


Misty Robot [3]

Our study investigated how interactive a social robot needs to be for individuals to stay engaged in a conversation with it. We found that regardless of conversation level, individuals found value in the robot and were able to maintain conversation with the robot. We found no significant difference in any level of interaction. We believe this is due to the novelty effect of interacting with a social robot for the first time and plan to investigate this further in the future. The rest of this paper is laid out as follows: (II) Methodology; (III) Related Work; (IV) Results; (V) Conclusions.

Conditions according to Levels of Interactivity				
	Condition 1	Condition 2	Condition 3	Condition 4
Level of Verbal	Low	Low	High	High
Level of Nonverbal	Low	High	Low	High

II. Methodology

We recruited a total of sixteen participants from the Mirabella. The Mirabella is a retirement community connected to Arizona State University which promoted life-long learning and engagement [2]. We recruited sixteen participants from the independent living community. These individuals held a conversation with a Misty robot from MistyRobotics [3]. We chose Misty because it costs around $3,000 compared to NAO, which costs approximately $15,000 in 2021. It is paramount to use robotic applications such as Misty because many older

adults face financial hardship from the location they choose to age in place [1]. Our work can impact individuals from many different socioeconomic backgrounds by working with a lower-cost robotic platform.

The study used a 2x2 between-subjects Wizard of Oz approach allowing the experimenter, or "wizard", to communicate through the robot to the participant without the participant knowing. This is a between-subjects study where no individual was in more than one

condition. We include a within-subjects analysis of the post-interaction survey on each question to understand how the participant's answer changed over time.

Participants signed a consent template prior to interacting with the robot. This consent template stated they were interacting with a teleoperated robot, so we did not disclose at the end of the experiment the robot was human controlled. Of the sixteen participants, only one individual asked what teleoperated meant. We simply stated it meant everything controlling the robot was outside the room. The individual asked no more questions after that. Each participant was compensated $25 each time they interacted with the robot.

The study design was influenced by Rosenthal-von der Pütten et al. who investigated the effects of a virtual NAO robot verses a physical NAO robot in a 2x2 between-subjects study [4]. The Wizard was outside the room, giving the appearance that the robot was operating autonomously. Each session was video recorded.

The study had four different conditions, shown in Table 1. They are as follows, respectively: low verbal and low nonverbal; low verbal and

high nonverbal; high verbal and low nonverbal; and high verbal and high nonverbal.

We define low verbal communication as responses that are less than three words. We define high verbal communication as complete sentences that mimic a natural conversation and have no restriction on word count. We define low nonverbal as the robot only being able to nod or shake its head. We define high nonverbal as the robot displaying as many as nine different emotions during the interaction. These emotions include sad, mad, happy, love, laugh, amazement, confusion, nod, and shake.

The Wizard did not follow a script with interacting with the participants. Since the direction of the conversation was constantly adapting, a script would have limited the Wizard's abilities. During the low verbal interaction conditions, the Wizard would use phases such as "how amazing", "that is sad", "why", or "tell me more" to indicate the robot was engaged in the conversation. If asked a question, the robot would respond using three words or less. During the high verbal interaction phases, the Wizard would use the common phases from the low verbal conditions in attention to complete sentences that naturally derived from the conversation. These might include "can you tell me more please?", "I am sorry for your loss" when a participant told a sad story, or other questions that arose during the conversation.

The goal was to recruit five people per condition; however, because of COVID-19 and the length of this study, we were able to recruit four subjects per condition. When we began this study in early June of 2021, the Mirabella had just lifted their COVID-19 rules. We speculate this played a factor in the recruitment outcome for this study.

Participants completed eight sessions with the robot, with a session lasting thirty minutes to an hour. After each session, the participant completed a survey regarding their experience. These sessions took place over the course of four weeks on different days. Due to this being human research, we had to be flexible on when individuals scheduled their sessions with the robot. All participants had eight separate days they interacted with the robot. The survey consisted of 18 questions rated on a five-point Likert Scale. Each question alternated between a positive and negative connotation to ensure each participant thought about the answer they gave. After completing all the sessions, we mapped responses over time. We then conducted an open interview with the participant regarding their responses.

The conversations participants had with the robot were unstructured allowing conversation to flow naturally. We provided a list of conversation prompts for individuals who

struggled to find a topic to discuss. Often, participants would read one prompt then the conversation would naturally flow from there.

III. Related Work

Abdollahi et al. developed Ryan, a home companion robot, that is capable of engaging the users by asking simple questions or telling a story from a photo album [5].

Khosla et al. placed a robot, Betty, in the home of individuals living with dementia. Betty can tell the user a story, reporting news, providing reminders, and engaging in cognitive games [6].

Iwabuchi et al. used Sota to help reduce behavioral symptoms of people living with dementia [7]. Sota can initiate conversation, offering conversation topics, and suggesting conversations that evoke emotions. This is done by choosing a preloaded conversation topic from a list.

Martin et al. use NAO in therapy sessions for older adults living with dementia [8]. In these sessions, NAO would sing music and dance, tell stories, and do mimicking exercises.

The Alzheimer Association recommends conversational therapy and reminiscence therapy for people living with dementia; yet little work is focusing on natural, reciprocal conversation between a social robot and the user. Researchers need to understand what level of conversation is required for users to feel engaged with the robot for the greatest therapeutic benefit. Additionally, understanding these levels is essential to engaging healthy seniors in conversation with a social robot. As mentioned above, we do not always live with this disease so developing a robot that can age with us may help prevent isolation later in life.

IV. Results

We conducted a mixed-method ANOVA test on the survey questions. Here, we report on four questions. This method is advantageous due to the between-subjects factor, i.e., the level of verbal and nonverbal, and the within-subjects factor, i.e., the session number. We chose to report on the survey questions regarding the participants' experience and attitude towards the robot. We did not analyze all questions with the within-subjects variable. We chose these questions because related work in the field does not focus on healthy older adults for social robots and whether these subjects found the interactions valuable. All questions examine the hypothesis that session number influenced how people felt about the question.

A. "I had fun talking to the robot"

This question provided valuable insight into how older adults may use this technology in the future. Individuals are more likely to use social robots for personal use rather than therapeutic if they are fun and enjoyable to interact with over long periods. Our hypothesis is that participants in conditions of low verbal interactivity (i.e., conditions one and two) will not enjoy their interactions as much compared to conditions of high verbal interactivity (i.e., conditions three and four) due to the robot's limited responses.

A mixed ANOVA showed no significant difference [$F(1,12)=0.042$, $p=0.842$] for the level of verbal, [$F(1,12)=1.674$, $p=0.220$] for the level of nonverbal, and [$F(1,12)=0.784$, $p=0.393$] for the interaction between verbal and nonverbal, refuting our hypothesis, and showing that all participants had fun interacting with the robot regardless of the level of interaction.

A one-way repeated measures AVOVA showed no significant difference for the session number [Wilks' Lambda=0.427, $F(7,6)=1.149$, $p=0.441$], refuting that session numbers influenced if participants had fun interacting with the robot.

B. "I was not engaged in the interaction"

This question provides insight into what levels of communication are needed for individuals to stay engaged. Our hypothesis is that participants in conditions of low verbal interactivity (i.e., conditions one and two) will feel less engaged due to the limited responses from the robot.

A mixed AVOVA showed no significant difference [$F(1,12)=0.854$, $p=0.374$] for the level of verbal, [$F(1,12)=0.007$, $p=0.934$] for the level of nonverbal, and [$F(1,12)=0.007$, $p=0.934$] for the interaction between verbal and nonverbal, refuting our hypothesis, the less verbal robot will make people feel less engaged.

A one-way repeated measures AVOVA showed no significant difference for the session number [Wilks' Lambda=0.513, $F(7,6)=0.813$, $p=0.608$], refuting that session numbers influenced if participants were engaged with the robot.

C. "I felt I had meaningful conversation"

This question provides valuable insight into the topics covered when speaking to the robot. While the term 'meaningful' is a subjective descriptor, it can be assumed most people conversed about topics that meant something to them rather than small talk such as exchanging pleasantries or asking about the weather. Our hypothesis is that participants in conditions of low verbal interactivity (i.e., conditions one and two) would not feel they had meaningful conversation due to the robot having a limited number of words.

A mixed AVOVA showed no significant difference [$F(1,12)=0.251$, $p=0.626$] for the level of verbal, [$F(1,12)=0.016$, $p=0.902$] for the level of nonverbal, and [$F(1,12)=1.269$, $p=0.282$] for the interaction between verbal

and nonverbal, refuting our hypothesis, the less verbal robot will make people feel their conversations are not meaningful.

A one-way repeated measures AVOVA showed no significant difference for the session number [Wilks' Lambda=0.422, F(7,6)=1.173, p=0.431], refuting that session numbers influenced if participants felt they had meaningful conversation.

D. "I would not consider the robot my friend"

Our first hypothesis is that participants in all the conditions would gradually accept the robot as their friend as they progressed. The second hypothesis is participants in the high verbal interactivity (i.e., conditions three and four) would feel the robot is their friend due to the more natural responses.

A mixed AVOVA showed no significant difference [F(1,12)=0.132, p=0.723] for the level of verbal, [F(1,12)=2.733, p=0.124] for the level of nonverbal, and [F(1,12)=0.002, p=0.968] for the interaction between verbal and nonverbal, refuting our hypothesis, that the level of verbal influences how people feel about the robot being their friend.

A one-way repeated measures AVOVA showed a significant difference for the session number [Wilks' Lambda=0.440, F(7,6)=1.092, p=0.465], supporting our first hypothesis, participants developed a friendship with the robot overtime.

E. Conversations with Misty the Robot

During the conversations, participants were encouraged to discuss any topic they desired to help stimulate a natural conversation. Participants agreed for the session to be filmed, so they did not disclose any information they were uncomfortable for the research team to review.

Many participants told the robot about their life, where they grew up, and activities they did as a teenager or young adult. They also talked about vacations they have taken in the past and their favorite parts of those vacations. Participants told the robot about their family members, ones who are alive and ones who have passed such as their parents and grandparents. Some individuals lost their parents recently due to the COVID-19 pandemic and discussed with the robot how difficult it was to lose them in such difficult times. All sixteen participants discussed their careers from their first job to retirement.

Other popular topics included discussing COVID-19 and how it has affected them along with vacations that needed to be rescheduled due to COVID-19. Individuals told the robot about current events in their life such as taking classes, getting the booster shot, and fun activities they had planned for the week. Most participants choose to tell stories to the robot and enjoyed when the robot asked questions related to the story.

V. Conclusion and Future Work

People found value in all levels of interaction, an unexpected result from the study. All participants reported feeling they had a meaningful conversation, they were engaged in all eight sessions, and each session was fun even though they are not isolated and healthy. Individuals expressed in the interview they had a meaningful conversation because they guided the conversation. Many people told the robot, "Thank you for listening, you have allowed me to tell old stories."

Of the sixteen people that participated, only seven reported feeling like the robot was their friend. During the open-ended interview, reasons for why the robot was not the person's friend varied. These included that the robot was not engaging enough to be a friend, the robot did not know enough about them to be a friend, the robot did not share stories the way a friend would, and finally, they will not ever consider it a friend because it is a robot. These responses provide valuable insight into the next steps for social robots for healthy individuals.

All participants reported they desired their robot to have more verbal and nonverbal features during the interview; therefore, we believe the novelty effect of interacting with a social robot for the first time played a significant role in the results presented here. In the future, teams should work to provide robots with more interactive verbal features. Additionally, it would be beneficial to have conversation prompts preloaded in the robot for when the conversation begins to dwindle. This feature will help the person feel less pressure to think of conversation topics, which was reported as a difficult feature of this study during the interviews. The team will investigate how much the novelty affect effected the study results in future work.

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