Is Now a Good Time? Opportune Moments for Interacting with an Ikigai Support Robot

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ABSTRACT

One of the questions human-robot interaction (HRI) research needs to address prior to in-home robot deployment is when optimal moments for everyday interaction might occur. These can vary based on robot users' existing routines and personal preferences. As part of a larger project to design a conversational robot that can assist older adults in recognizing and maintaining their ikigai (sense of meaning and purpose in life), we explored the question "when might be good times for the robot to engage older adults in activities?". 11 older adults who were familiar with our prototype robot from prior participation in our research took part in a two week-long "diary study" to identify their habits and preferred times of engagement with the robot. The diary was performed by sending text messages to the older adults twice daily, asking what they were doing at the moment and whether this was a suitable time for interacting with the robot. The findings of the study allowed us to determine optimal times for interaction with the robot' - commonly before and after lunch and before sleep. Insights from this approach contribute to designing robots that can be integrated into the daily lives of older adults.

CCS CONCEPTS

• **Human-centered computing** → **Participatory design**; *User centered design*; • **Computer systems organization** → **Robotics**.

KEYWORDS

Diary, Older Adults, Optimal Timing, Longitudinal Panel, Co-design, Social Robots

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1 INTRODUCTION

As conversational agents become commonplace in our everyday lives (Amazon Alexa, Google Home [22], Siri, Microsoft Cortana [28], etc.), robotics researchers have explored how conversational robots — conversational agents with physical embodiments — can enhance people's lives. One particular line of research has studied how social robots could help older adults to enhance and maintain their well-being [13, 15, 19, 21, 24] by, for example, prompting them to have conversations about topics that are important to them [21]. This kind of prompting is reminiscent of health literature that explores cues triggering healthy behaviors, in which it is known that the timing of the prompt is critical [26].

Researchers often determine the robot's optimal timing by analyzing the usage patterns collected directly from the robots themselves. For instance, an Alexa usage study observed weekly patterns across ages 4 to 55 [17]. Karotz robot research tracked usage by individuals aged 8 to 77 over six months, analyzing changes over time [8]. Another study on a pet-like robot used sensor data to compare interactions of younger adults in Korea and the U.S. [4].

Date and timestamped diary studies, which capture one's immediate experiences and behaviors [20], can also serve as a methodology for capturing when it is appropriate to prompt and interact with a robot. In previous HRI studies, care staff recorded older adults' interactions with the ready-for-deployed animal-like robot Paro or

Joy for All in supported living facilities [5, 6], and parents recorded the co-learning experiences of their family in a robot camp [1]. Studies have also explored how robots can assist users in maintaining diaries [2, 16], such as through daily check-ins [2] or facilitating the sharing of emotions [16]. Similar to a diary approach, other research has used ecological momentary assessments (EMAs) — using mobile phone apps to remind the user of scheduled assessments and triggers — to collect user data in real-time [7]. They recruited adults 20-35 years old and pinged the participants 5-7 times a day via their smartphones to obtain user experience with the robot [4]. These studies have successfully collected detailed data on the interaction of users with ready-to-deployed robots in the course of their daily lives. However, many robots are not-yet-ready-for-deployment, and different populations (e.g., older adults) may have different usage patterns and preferences from those that have already been studied.

For not-yet-ready-for-deployment robots designed for older adults, researchers usually do not explicitly study when and how frequently people want to interact with them. In most studies, researchers are focused on other research questions and peremptorily decide the timing of interactions for participants. For example, a study using the telenoid, an android robot to facilitate conversations with older adults living with dementia, scheduled sessions three times a week (on Monday, Wednesday, and Friday) [27]. Although the robot demonstrated a reduction in anxiety for older adults [27], a question remains– *could a different temporal pattern have yielded better results?* A critical gap exists for interaction design research tailored for older adults, aiming to understand their timely preferences in order to program or integrate into not-yet-ready-for-deployment robots, ensuring the robustness necessary for deployment in an older adult's home. This is the purpose of our research.

2 BACKGROUND CONTEXT OF THE STUDY

Our diary study was conducted within the scope of a larger project involving the design of a "ikigai" support robot collaboratively developed with a group of older adults in a longitudinal panel [10–12, 14, 15, 21]. The robot was not-yet-ready-for-deployment, in the developmental phase during the study. In the following section, we explain the concept of the robot, its activities, the structure of the longitudinal panel, and our participants.

2.1 The ikigai support robot and the activities

"Ikigai," Japanese concept of one's meaning and purpose in life [9], is the conceptual foundation of the project. To design the ikigai support robot, we designed activities for and deployed on the commercially available QT robot from LuxAI [18]. In particular, we designed three specific activities that could encourage people to reflect on the activities in their lives that bring them ikigai. This design allows for both the robot and the older adult to initiate prompts and activities. (1) *General Chat*: the robot would engage in casual conversation about the participant's daily activities, people, and things that bring them meaning. (2) *Photograph Activity*: the robot prompted participants to share a personal photograph, then asked them questions about the meaning and purpose related to that photograph. (3) *Reflection Activity*: The robot encouraged individuals to reflect on their recent past, anticipate the near future and acknowledge personal accomplishments. The activities were designed to flexibly integrate into the everyday lives of older adults, allowing for the robot or the older adult to initiate activities.

2.2 The co-design longitudinal panel and the participants

We conducted the diary study as part of a broader longitudinal panel, a co-design process that included multiple co-design sessions involving the same 11 older adults who come together monthly to discuss and critique the evolving robot design. The participants, aged 62 to 85, included seven women and four men. We used their self-created pseudonyms in this paper to ensure anonymity.

Before engaging in the diary study, the participants had already participated in seven panel activities. These prior sessions covered topics such as getting acquainted, discussing ikigai, exploring personal photographs, assessing robot movements, designing facial expressions and sounds, and evaluating the robot. During some of the periods between panels, participants were assigned reflective "homework." The diary study was the seventh panel's homework, and participants received a $40 gift card as compensation for their time and contribution to this homework.

3 METHODS

3.1 Research Questions

To find the optimal timing for robot interactions, the diary study was guided by the following research questions:

- *What is an appropriate time for the robot to prompt older adults to interact with it?*
- *How do other personal factors, such as one's activity and/or companions, influence the appropriate time to prompt?*
- *How can we design a diary study for older adults, as part of the co-design process, to understand the appropriate prompting time for a robot and behavior without having an actual robot interacting with them?*

3.2 Diary study design

As a way to collect data from our participants, we decided to use text messages to prompt participants to open the online survey where data was collected — something that the participants were already familiar with. To do this, we created a simple Python script that randomly selected two times during the day between 6:00 and 22:00 to send research participants a text message containing a reminder to fill out the diary (see Fig 1(A)). The text messages directed them to a diary in a survey format (Qualtrics, Seattle, USA), which could be opened with their phone browser (see Fig 1(B,C)). Participants had the flexibility to respond to the text when they viewed it at a convenient time. The diary questions included "*What are you doing right now*," "*Where are you*," "*Who are you with*," "*Do you think it would be appropriate to use [the robot] at this time*," "*If you would use [the robot], what should [the robot] be doing with you*," "*Why is it not appropriate to use [the robot] right now?*".

We introduced the diary concept to participants by sending a sample text message to them during the co-design panel prior to running the study. We went step by step together with the participants, reading the text message and clicking on the link to the diary

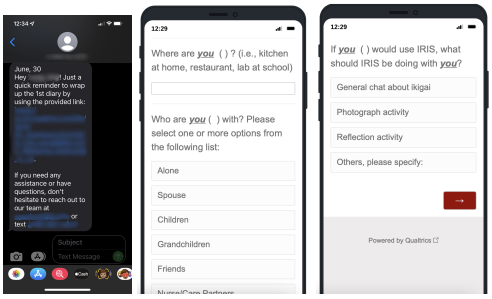

Figure 1: (A) Example of a text message with url link to online survey. (B, C) Examples of diary questions.

with them. We also told them they could proceed to the next diary if they missed a diary entry.

We sent emails during the study to check in with participants and see if the participants fully understood the diary process. Their feedback indicated confusion over imagining scenarios versus recording real activities. In response, we personalized diary instructions with participants' names and added examples for clearer questions.

The diary study lasted two weeks (14 days), and the group met four weeks after the start of the study in the next longitudinal panel. During this session, we presented the initial results from the study about the appropriate timing to interact with the robot, fostering participants' reflection on the robot and later panel activities.

Within our diary study, we encountered challenges with two participants living with dementia who faced difficulties understanding and keeping up with the diary study. While they were able to fill in the first few days of the diary with extensive help from our team and their caregivers, we decided to halt the diary for these two individuals and conducted a 1-hour interview with them instead. We asked them their preferences for the optimal location, time of day, and location for robot interactions in their living environment. The initial diary entries and interviews from the two individuals were integrated into the findings.

3.3 Analysis

We conducted the study in the Summer of 2023 and collected 230 diary entries. For analysis of text responses, such as the activities or reasons for not using the robot, we independently categorized and coded the data. Following individual analyses, the team engaged in discussions to collectively categorize each text data. The numerical responses were processed into charts and graphs using Python and GraphPad Prism (California, USA). The follow-up co-design session and individual interviews were recorded, transcribed, and specific sentences aligning with the theme were selected.

4 FINDINGS

4.1 What we learned from the diary

4.1.1 When is it appropriate to use the robot? In Fig 2 (A), we show that our participants were more likely to use the robot on Mondays, Thursdays, and Saturdays. Participants also tended to find early morning (6:00-8:00), early afternoon (12:00-16:00), and before sleep (20:00-22:00) as appropriate times to use the robot (Fig. 2 (B)). In individual interviews, similar preferences were noted: Catina$_{72/F}$ specified "*around 7:30 in the morning*" for initial conversations, while HAL-9000$_{76/M}$ suggested "*after ...first cup of coffee.*"

Secondly, as shown in Fig. 2 (C), the timing also greatly depended on who participants were with. For example, participants found it was mostly inappropriate to use [the robot] when in the presence of others (92.9%), compared to when in the presence of friends (76.5%), a spouse (51.5%), or alone (64.6%). Catina$_{72/F}$ indicated in her interview that she's comfortable talking to the robot alone or during "*calls with my sister.*"

Since we designed the robot to be used at home, participants would be more likely to interact with the robot if they were at home (50.0%) compared to outside at home (7.70%), car (7.70%), or other locations (13.60%) such as eating outside or being in a community space (Fig. 2 (D)). Likewise, Catina$_{72/F}$ and HAL-9000$_{76/M}$ suggested situating the robot in a particular spot in their room, indicating a higher likelihood of engaging with the robot at home.

Next, participants mentioned contextual reasons for times when they did not think it would be appropriate to interact with the robot. Sometimes it was inappropriate to use the robot because they were busy eating, reading, cooking, outside, gardening, or driving in a car. They also needed some alone time, were away and not at home.

4.1.2 Appropriate activities when interacting with the robot. We also asked about which of four activities, through multiple selection, should the robot be doing if they indicated it was appropriate to use the robot. The selected preferences for these activities were as follows: 'general chat about ikigai' (31%), 'reflection activity' (26%), 'photograph activity' (8%), and 'others' (35%). For others, participant proposed activities that included playing music, providing knowledge or weather updates.

4.1.3 Discussion of optimal timing after the diary study. The diary study's findings guided discussions in subsequent panels, with participants expressing preferences for specific robot interaction times and topics, aligned with their daily routines. For example, JJ$_{70/F}$ emphasized the importance of "*planning of the day in the morning, [knowing] when your next coffee was coming up*," similar to the current routine of daily calendar consultation. Regarding the reflection activity, the Wise One$_{75/M}$ saw end-of-day reflections as a diary-like activity, proposing the robot could help remind *"for things that happened today"*. In addition, Big Daddy$_{65/M}$ suggested bedtime reflection could revisit shared photos from photo-activity as a part of this ritual, while John$_{73/M}$ expressed a possibly for sharing with future generations.

4.2 General feedback from the diary study

Overall, most of the participants found the diary easy to use, where Anna $_{85/F}$ mentioned, "*I thought it was pretty easy to do... I'm real comfortable.*" However, some improvement could be made.

Big Daddy$_{65/M}$ suggested surveying participants about activities that support their ikigai prior to the diary study, and subsequently reminding them of those activities when filling out the diary. It could be especially helpful for the participants who can't remember the activities that brings them ikigai from time to time: "*Every time the survey [diary] comes up, every page, my ikigai statements across the top.... especially at different times of day, ... Like right now I'm having kind of a health problem... if I were to have that diary in front of me right now, I would have a little bit difficult time focusing.*"

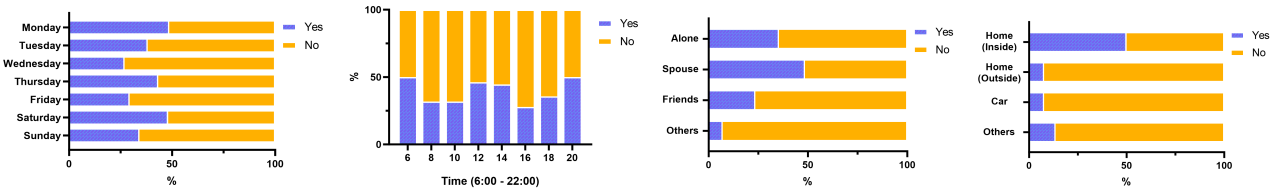

Figure 2: (A) Appropriate Days to use the robot, (B) Appropriate Times to use the robot, (C) Appropriate people to use the robot with, (D) Appropriate locations to use the robot

The participants also mentioned a limitation in using phones as diaries, responding to entries only when they saw text messages, usually at certain times of the day, rather than at random intervals: "*I don't look at that [the phone] all day. And then the evenings. Oh oh, there it is again! I better get it done! ... Is this second day one, or is this the first day, wherever I saw it, I just did it* ($JJ_{70/F}$)." Similarly, Big Daddy $_{65/M}$ mentioned how he sometimes would use his mobile phone in the bathroom. This was why it was inappropriate because "*Fact is, when I did my diary, a number of times I was in the restroom. And I said 'is this an appropriate time?' – 'no.' That's a privacy issue.*"

5 DISCUSSION

5.1 Appropriate Timings and Future Work

The diary study within the greater co-design project provided crucial insights into the optimal timing for prompting older adults.

We identified for our group of older adult participant, Mondays, Thursdays, and Saturday early morning (6:00-8:00), early afternoon (12:00-16:00), and 20:00-22:00 as ideal times to use the robot. These times were suitable as they aligned with the participants' existing habits, like using early mornings for calendar reminders and night reflections as a diary-like recap of the day. Participants also proposed ideas like recording daily reflections for future generations or using the photo-activity as a prompt for the reflection activity.

Although we did not provide detailed data on the specific factors, it highlighted the significant impact of context and location in identifying optimal times for robot to prompt. The robot should be able to determine the nature of the older adult's engagement with the robot and with other people, allowing for continued conversation if the participant was interacting with a spouse, but waiting if the participant was engaging with friends or others. The use of the robot in the presence of others seems tied to their trustworthiness and closeness, possibly due to the intimate nature of ikigai discussions or older adults' self-image concerns [25]. The robot should also understand if the user was busy doing activities, such as eating, cooking, or not present in the setting.

We also showed other possible applications for a conversational robot. The results indicated a general acceptance of reflective activities among older adults and could have potential applicability to other studies focused on well-being and older adults. Additional robot functionality, such as sharing educational and factual information and playing music, were identified as important by our participants and could be implemented in future research.

It is worthwhile to acknowledge that when and how a person imagines interacting with a robot will very likely differ from the reality of actual use in a deployment and that these results were based on a small group of older adults. Moreover, the type of robot voice might also play a crucial role in prompting and robot usage, as we found that the robot voice can affect user behaviors [12]. Additionally, we did not track the gap between the time when the participants created prompts and the receipt of responses from participants, which could reflect the phone usage patterns of participants in their diary entries. These are interesting directions for future work.

While the effect of these activities on well-being wasn't the main focus of our study and their impact remains to be researched, identifying optimal times for robot-initiated interactions helped us better design the robot for real-world implementation in the future.

5.2 The Diary Study in the Longitudinal Panel

While recognizing that the diary experience may not fully replicate results obtained from a real or log file, as observed with actual robots [8, 17], the research conducted within the longitudinal panel provides valuable insights. The diary and the discussion in the panel were helpful in guiding us on how to program or integrate the best times for the robot to prompt users for different robot activities.

Feedback from participants offered valuable insights into enhancing diary studies within longitudinal panels. First, to avoid participants answering the same question at the same time daily because of their mobile usage pattern, the diary could incorporate the time it was sent. Researchers could survey participants about activities that bring them ikigai, and include these answers as reminders when filling out the survey. Additionally, participants could be encouraged to answer the diary outside restroom times or contemplate the activity diary even if responding in the restroom, thereby enhancing the accuracy of reported activities. For participants living with dementia, alternative methods such as the "shadow" method, similar to observations in "robot in the wild" studies [23] or systematic social observation [3], could be explored to address challenges encountered with the phone-based diary study. These adjustments are all opportunities for future studies.

In conclusion, by incorporating the diary method as a component of a co-design longitudinal panel, we successfully obtained valuable insights from participants regarding the appropriate timing for an ikigai support robot, that could be further programmed or integrated into the homes or aging facilities of older adults.

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