Let's Talk About You: Development and Evaluation of an Autonomous Robot to Support *Ikigai* Reflection in Older Adults

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***Abstract*— The sources of a person's *ikigai*—their sense of meaning and purpose in life—often change as they age. Reflecting on past and new sources of ikigai may help people renew their sense of meaning as their life circumstances shift. Building on insights from an initial Wizard-of-Oz robot prototype [1], we describe the design of an autonomous robot that uses a semi-structured conversation format to help older adults reflect on what gives their life meaning and purpose. The robot uses both pre-determined (scripted) and Large Language Model (LLM) generated questions to personalize conversations with older adults around themes of social interaction, planning, accomplishments, goal setting, and the recent past. We evaluated the autonomous robot with 19 older adult participants in a lab setting and at two eldercare facilities. Analysis of the older adults' conversations with the robot and their responses to an evaluative survey allowed us to identify several design considerations for an autonomous robot that can support ikigai reflection. Interweaving simple yet detailed pre-determined questions with LLM-generated follow-up questions yielded enjoyable, in-depth conversations with older adults. We also recognized the need for the robot to be able to offer relevant suggestions when participants cannot recall events and people they find meaningful. These findings aim to further refine the design of an interactive robot that can support users in their exploration of life's purpose.**

I. Introduction

As we age, navigating retirement, facing physical and sometimes cognitive decline, and experiencing reduced social ties, finding our evolving *ikigai*—the Japanese concept of meaning and purpose in life [2], [3]—can become more challenging [4], [2]. The loss in the search for ikigai can negatively impact us, leading to increased risks of physical, mental, and cognitive health issues, such as depression and anxiety [5], [6], [7]. One way to help us find our sense of meaning is to take a moment to pause and view our lives from a fresh perspective [8]. However, personal reflections can often go in multiple directions, sometimes to things not related to ikigai. While several books [2] and journal-style workbooks [9] are marketed to help guide people as they engage in such reflections, these offer a one-way experience rather than an interactive, back-and-forth engagement that can enhance reflection.

A social robot could provide a more interactive way of engaging people in reflection about their ikigai. Social robots have previously been successfully used to encourage reminiscence and self-reflection in older adult users [1], [10]. However, in these previous studies, the robots only used preset questions, and participating older adults highlighted the importance of conversation-specific, personalized responses for deeper engagement. In this paper, we describe the development and evaluation of a robot with autonomous conversational abilities that offers contextually appropriate feedback to the user to deepen their self-reflections.

To address the challenge of *designing an autonomous robot that can help older adults discover their ikigai, or sense of meaning and purpose in life*, we used co-design with older adults to build on an initial Wizard-of-Oz (WoZ) robot prototype designed by Randall et al. to support ikigai related reflection and evaluated with older adults in Japan [1]. Our autonomous robot incorporates a combination of pre-determined and Large Language Models (LLM) generated follow-up questions and nonverbal gestures tailored to the robot's speech to provide personalized guidance to older adults as they go through the reflection activities.

II. Related works

A. Reflecting on one's ikigai

Ikigai, or a sense of meaning in life, emerges not simply from living life but from reflecting on and making sense of one's life's experiences [11]. Ikigai literature highlights the importance of deriving satisfaction from past achievements, savoring present moments, and setting future aspirations [12]. This parallels the Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment (PERMA) model [13], [14], [15], which framed the initial WoZ prototype this work builds on [1].The PERMA model suggests that "meaning" emerges from a sense of connecting and contributing to something larger than oneself, a notion rooted in past experiences and inclusive of the concept of "accomplishment" over one's lifetime [15]. Authentic relationships also play a crucial role in achieving ikigai, aligning with the positive relationships aspect of the PERMA model [16]. Integrating the principles of ikigai with the PERMA model suggests that reflecting on accomplishments, recent past events, social interactions, and future aspirations could offer a structure for individuals to pause and reflect deeply on their lives. This approach showed promising results for engaging older adults in ikigai-related reflection [1]. However, the initial WoZ prototype developed was limited by its inability to adapt to the context of specific conversations, suggesting the

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need to create a more contextually attuned autonomous robot design, which we develop and evaluate in this paper.

B. Reflection with robots

Reflecting on one's *ikigai* could be enhanced with a conversational partner, including an Artificial Intelligence (AI) agent, as reflection requires time, guidance, and support [17]. The physical embodiment of a conversational robot adds a dimension of engagement, persuasiveness, and trust that may make people more comfortable sharing personal information and yield a more natural and enjoyable interaction [18], [19].

Studies on robots facilitating "reflection" have primarily been related to reminiscence practices [20], [21], [22] and cognitive assistance [23] to enhance one's memories. For instance, the Eva robot was used in cognitive stimulation therapy sessions to boost cognitive functions [20]. Similarly, Pepper [22], equipped with photographs displayed on the robot's tablet, has been used in reminiscence therapy, along with meaningful photographs to aid cognitive exercises for individuals with dementia. These interventions often focus on personalized reminiscence, engaging individuals in discussions about significant people, places, and events in their past [24]. González et al. developed a robot with limited preset phrases to inspire self-reflection among older adults [10]. In contrast to research employing robots for reminiscence and cognitive enhancement, the work presented here focuses on exploring the deeper meanings of older adults' prior experiences and future plans.

Research on robots that support reflection on life's meaning and purpose has been scarce and exploratory. While there have been investigations into gratitude reflection among older adults and their caregivers [25] and reflective storytelling in child-robot interactions to promote reflective play [26], these studies have not explored the concept of ikigai or one's life purpose. Initial efforts that examine ikigai through the lens of exploratory design highlighted the role of social activities [27] and how older adults' perceptions of ikigai align with their goals and daily contentment [3]. More research is needed on leveraging robot interactions to facilitate deep reflection on personal meaning and purpose in life.

To address this gap in literature, we created an autonomous robot prototype for engaging participants in reflection about life's meaning and purpose. We expanded on the previous WoZ prototype, which integrated the PERMA model into ikigai reflection by using a robot to engage people in a pre-determined conversation on their recent past, future, social connections, and accomplishments [1]. An evaluation of this WoZ system involving 15 older adults underscored the importance of simplifying language and acknowledging users' responses in context-specific ways to facilitate deeper engagement [1]. The autonomous activity design described here seeks to address those design recommendations and was further informed by co-design input from a longitudinal panel which involved iterative testing of the autonomous robot functions with older adults (described in detail in [28], [29]).[1]

[1]In our discussion of the design process below, we use older adults' self-created pseudonyms to identify direct quotes.

Fig. 1. An older adult engaged in the automated reflection activity with our robot.

III. The Autonomous Reflection Activity Design

Similarly to the initial WoZ prototype, the autonomous reflection activity presented here is structured around several ikigai-related topics, with the robot engaging participants in a conversation on each topic followed by 10 seconds of silent reflection (see [1] for more details of the overall reflection activity design). The topics include accomplishments, recent past, social interaction, planning, and goal setting. To further improve the activity design, we automated the conversation flow to ensure the dialogue between the user and the robot is dynamic. We also programmed the robot to display more agentic behavior, such as showing appropriate facial expressions, nodding, and slightly moving its arm while listening.

To create a fluid conversation between the user and the robot, we interleaved pre-determined questions (structured flow) and a series of LLM-generated follow-up questions (personalized content). The pre-determined questions guided the overall flow of the activity, while the LLM-generated follow-up questions allowed the robot to personalize the interaction with the current user. Table I presents the conversation flow for each activity, which we implemented using our easily adaptable social robot programming framework [30] with two basic types of instructions to the robot: `say` a *pre-determined question* verbatim, and `acknowledge` with or without additional information to generate *LLM-generated follow-up questions*. If a user struggles to answer particular questions, the robot transitions to the next pre-determined question, ensuring an uninterrupted conversational flow.

We also made several changes to our activity design based on the feedback of older adults who participated in our co-design sessions. We tried to prevent abrupt topic transitions, which could be unsettling for participants; for example, $\text{JJ}_{70/F}$ noted, "*it was kind of scary because it jumped topics without a natural flow.*" We also simplified the questions and procedures. For example, instead of asking participants to choose from among all five topics at the start of the interaction, $\text{Big Daddy}_{65/M}$ suggested that the robot "*start with two topics they can choose from*."

The activity was implemented on the QTrobot from LuxAI [31], which has an expressive face and can move its arms and head.

IV. Methods

A. Participants

By word of mouth, we recruited 19 participants, ages 64 to 96 (average 81.6 years), living in the midwest U.S. The

TABLE I

ROBOT-ASSISTED REFLECTION ACTIVITIES

Accomplishments: Reflect on lifetime meaningful past achievements. 16 participants.

1) `Say` "*Let us start with something that you're proud of and you've accomplished during your lifetime.*"
   - `Acknowledge`. `Say` "*How do you feel about the achievement?*"
2) `Acknowledge`. `Say` "*What have you accomplished in the last three months that you are proud of? It can be something small and meaningful.*"
3) `Acknowledge`. `Say` '*What are some things that you have accomplished in the last week? If you have trouble, remember that accomplishments in this time frame are small, like finishing a book.*"
   - `Acknowledge`. `Say` "*How does knowing you have achieved these things make you feel?*"
4) `Acknowledge`. `Say` "*Okay, let us take 10 seconds and celebrate yourself in your mind, or however you would like. I will let you know when 10 seconds is up.*"
   - Pause 10 seconds. `Say` "*How are you feeling after reflecting on your accomplishments? Is there anything you would like to share?*"
   - `Acknowledge`.

Recent Past: Positive and meaningful experiences from the past week. 10 participants.

1) `Say` "*Let us start talking about what you have been doing recently. Did you do anything that makes you happy? For example, recently, I have been talking to my friends more, and that makes me happy.*"
   - `Acknowledge`. Call GPT with: "Based on the user's response, the agent will ask a follow-up question related to the activity the user mentioned."
   - `Acknowledge`. Call GPT with: "Based on the user's response, the agent will ask a follow-up question related to the activity the user mentioned."
   - `Acknowledge`. Call GPT with: "Based on the user's response, the agent will ask a follow-up question related to the activity the user mentioned."
2) `Acknowledge`. `Say` "*Did you have any meaningful experience through the activity you did recently?*"
   - `Acknowledge`. `Say` "*What emotions did you feel during the experience?*"
3) `Acknowledge`. `Say` "*Spend 10 seconds thinking of the experience and the emotions you felt during it and make it as vivid as possible in their mind.*"
   - Pause 10 seconds. `Say` "*Thinking about what you have visualized, what do you think is important to you that gives you happiness and brings meaning to your life?*"
4) `Acknowledge`.

Social Interaction: Positive relationships and interactions with individuals in participants' lives. 16 participants.

1) `Say` "*Do you feel you have enough meaningful connections with others?*"
2) `Acknowledge`. `Say` "*Did you speak to anyone in the past week that was particularly meaningful?*"
   - `Acknowledge`. Call GPT with: "The agent will ask the user a follow-up question based on the user's response."
3) `Acknowledge`. `Say` "*Is there a way you were able to help someone during the week?*"
   - `Acknowledge`. `Say` "*Can you think of any ways you can help your friends, family, or community this week?*"
   - `Acknowledge`. Call GPT with: "The agent will ask the user a follow-up question based on the user's response."
4) `Acknowledge`. `Say` "*Let us take 10 seconds to think about your social connections and if you want to make any changes to them. I will let you know when 10 seconds is done.*"
   - Pause 10 seconds. `Say` "*Your 10 seconds is done, would you like to share your thoughts?*"
5) `Acknowledge`.

Planning: Short-term plans important for participants for the day and the following day. 12 participants.

1) `Say` "*Do you have any plans for today and tomorrow?*"
   - `Acknowledge`. Call GPT with: "Based on the user's response, the agent will ask a follow-up question."
   - `Acknowledge`. Call GPT with: "Based on the user's response, the agent will ask a follow-up question."
2) `Acknowledge`. `Say` "*Did you want me to schedule a reminder in your calendar so you can remember [event name]?*"
3) `Acknowledge`. `Say` "*Is there anything you can do to make you feel more fulfilled and valuable?*"
   - `Acknowledge`. Call GPT with: "The agent will ask a follow-up question based on the user's response."
4) `Acknowledge`. `Say` "*Let us take 10 seconds to imagine how it would feel when the things that you have planned is done.*"
   - Pause 10 seconds. `Say` "*Your 10 seconds is done, thinking about what you visualized, what brings you the most meaning?*"
5) `Acknowledge`.

Goal Setting: Long-term goals meaningful for the future. 13 participants.

1) `Say` "*Think of your life one month from now. What can you do to make your life feel more valuable over the next month?*"
   - `Acknowledge`. Call GPT with: "Based on the user's response, the agent will ask a follow-up question."
2) `Acknowledge`. `Say` "*What is the one small thing you can do tomorrow to progress toward this monthly goal?*"
   - `Acknowledge`. `Say` "*How does finishing this step affect your goal for the month?*"
   - `Acknowledge`. `Say` "*How do you think you will celebrate after achieving this goal and the steps you are taking towards it?*"
3) `Acknowledge`. `Say` "*Let us take 10 seconds to imagine how it would feel to achieve this goal.*"
   - Pause 10 seconds. `Say` "*Your 10 seconds is done, thinking about what you imagined, how do you feel about the goal and achieving it?*"
4) `Acknowledge`.

Note: `Acknowledge` refers to calling GPT with the prompt: "*The agent will first briefly acknowledge the user's response to the agent's question.*"

demographic composition included 11 women, seven men, and one non-binary individual. Among them, 10 participants had prior experience interacting with robots, while the other nine had never encountered robots (see Table II).

B. Data Collection

The interaction with each participant lasted approximately one hour and was approved by the Indiana University Institutional Review Board (IRB). With one or two students moderating (later referred to as moderators of the study),

TABLE II
PARTICIPANT DEMOGRAPHICS

Participant #	Age	Gender	Race	Experience with robots	Dementia?	Sequence of Reflection Activity*
1	94	F	White	Not seen	Y	Goal
2	71	F	White	Seen	Y	Soc, Goal
3	79	F	White	Not seen	Y	Plan, Accom, Soc
4	80	M	White	Not seen	Y	Accom, Soc
5	95	F	White	Not seen	Y	Goal, Soc, Accom
6	94	M	White	Seen	N	Soc
7	96	F	White	Seen	Y	Accom, Goal, Soc
8	81	M	White	Not seen	Y	Soc, Plan, Accom, Goal, Past
9	82	F	White	Seen	N	Soc, Accom, Goal, Plan, Past
10	92	F	Asian	Seen	Y	Past, Accom
11	87	F	White	Seen	N	Soc, Accom, Plan, Goal, Past
12	80	M	White	Not seen	N	Accom, Plan
13	89	F	White	Seen	N	Soc, Plan, Accom, Past
14	71	Non**	White	Seen	N	Soc, Plan, Accom, Goal
15	82	M	White	Not seen	N	Past, Goal, Soc, Accom, Plan
16	75	M	White	Seen	N	Goal, Soc, Past, Plan, Accom
17	64	F	White	Seen	N	Accom, Past, Soc, Goal, Plan
18	69	F	Black	Not seen	N	Goal, Past, Accom, Plan, Soc
19	70	M	Black	Not seen	N	Soc, Plan, Goal, Past, Accom

*Soc = Social interaction, Plan = Planning, Accom = Accomplishment, Goal = Goal setting, Past = Recent past; **Non = Non-binary

the data was collected in semi-private, open spaces: a chapel in a local memory care facility, a corner of an unused cafe in a senior living community, and a university lab (see Fig. 1). After the participants arrived, we guided them through the consent form with an explanation of the interactions with the robot. They were informed about the availability of five discussion topics, from which they could select their preferences until they had engaged with all five or opted to discontinue. The compensation was the same regardless of the number of topics completed.

After interacting with the robot, we asked the participants to fill out an evaluative survey incorporating questions from the robot usability scale [32] to assess the robot's ability to maintain a themed discussion using a Likert scale with 1=strongly disagree and 5=strongly agree. The questions focused on various dimensions including the robot's *communication skills* (clear communication, keeping track of context, asking appropriate questions, easy to understand, accurate response), *helpfulness* (handles situations when the conversation is not clear, understands what the user wants, helps reflect on ikigai, shows empathy), *back-channeling methods* (waiting time for response from the robot, robot making appropriate sounds), and *physical movements*. We also interviewed participants on how they thought the activity went and if the robot could help them enhance their ikigai.

C. Data Analysis

Although the robot offers a comprehensive experience that includes physical embodiment and conversation, our analysis focuses on the conversational aspect. This aspect is crucial in facilitating reflection and was a main change from the original WoZ prototype (i.e., more follow-up questions). The analysis process began with three authors collaboratively examining the raw data through inductive analysis [33]. This approach allowed the team to transition from initial themes centered around the five key topics to a nuanced understanding of how each pre-determined or follow-up question fostered the conversation. The first author completed the qualitative analysis by interpreting the raw data and categorized the participants' responses: (1) *detailed* for responses where participants provided information related to the question, (2) *simple affirmation* for one-word affirmative answers (e.g. "yes"), (3) *uncertain* for expressions of uncertainty (i.e., I don't know) or repeat requests, and (4) *Disengagement* for lack of engagement, silence, direct refusal ("No"), or a quick shift to the next topic. The first author validated the coding of one participant's responses with the seventh author, with an inter-rater reliability of 0.94. While we did not directly code for ikigai responses, the detailed responses were crucial for evaluating the robot's success in inspiring in-depth reflection, which could potentially reveal one's ikigai.

For the survey results, the questions were grouped using factor analysis [34] with the python package 'factor-analyzer' [35]. Four factors were determined based on eigenvalues > 1. Survey questions were grouped when factor loading values were > 0.6. Three of the 15 questions were excluded as their factor loading was > 0.6. We calculated each factor's mean, standard deviation, Cronbach's alpha, and skewness.

V. RESULTS

A. What the robot did well

The robot's combination of pre-determined and LLM-generated follow-up questions successfully prompted participants to think deeply, as demonstrated by participants' *detailed* responses discussed below. We categorize the results by ikigai conversation topic.

1) Accomplishment: 16 of the 19 total participants talked with the robot on the accomplishment topic. Initially, the robot's *pre-determined question* guided the reflection on significant achievements in their lifetime and recent accomplishments. Fourteen participants (87.5%) reflected on meaningful life achievements when asked what they are

proud of achieving. For example, P15$_{82/M}$ reminisced about his extensive career as an electrical engineer in a detailed way, *"I worked 50 years as an electrical engineer. And I'm pretty proud of some jobs I worked on...."*

The robot's *pre-determined follow-up questions* about participants' feelings on the achievements they mentioned allowed 14 participants (87.5%) to explore their sense of pride and satisfaction further. For instance, P15 continued discussing his career and elaborated in detail: "*I installed the world's largest static VAR compensator and got it working. That was a big accomplishment. I played a significant role in [Company name]'s project at [place name], a [state] transmission line requiring 64 semi-trailer trucks for transporting all the necessary capacitors and protective equipment.*"

2) Recent past: Ten of the 19 participants reflected and shared what was meaningful in their recent past. The robot's *pre-determined questions*, such as the first question about what made them happy recently, allowed nine participants (90%) to share detailed and meaningful past instances in their lives. For example, P19$_{70/M}$ told the robot that his happiness was to "*communicate with my friends more. And also just communicate more with family,*" naming what he could do to bring him more happiness.

The *LLM-generated follow-up question* exploring the elements that contributed to individuals' happiness enabled nine participants (90%) to share details about what makes them happy. For example, following P19's answer of communicating more with family, the robot asked a question tailored to P19, `"What have you found to be the most rewarding part of this?"` This allowed P19 to go more in-depth about why his communication with his family in the recent past was important: "*Just being with each other. That means so much because people are so far away from each other now that just being able to talk to your family, somebody with some familiarity with you. It's a great thing.*"

After the ten-second reflection, the robot's *pre-determined follow-up question* allowed participants to emphasize what is meaningful in their lives and what is essential for them. For example, P19 emphasized that "*just being around family*" is his ikigai and is meaningful to him. These examples of P19's responses highlight the importance of interpersonal connections in defining his ikigai.

3) Social Interaction: 16 of our participants reflected on social interactions that were meaningful to them. The social interaction topic began with a *pre-determined question* about meaningful connections with other people, enabling 14 participants (87.5%) to engage in reflective discussions about the depth of their social connections. For instance, P7$_{96/F}$ expressed feelings of isolation and the challenges of forming close relationships, stating, "*Here, maybe I have, maybe four intimate relationships, but there are so many people here that I don't know...they don't wear their names...I just don't feel that I do enough to be a good partner in speech.*"

The *pre-determined follow-up questions*, particularly those asking whether participants had engaged in meaningful conversations in the past week, effectively prompted 12 participants (75%) to deepen their reflections, revealing instances of significant connections they previously overlooked. This approach led some participants to recognize relationships that contributed to their sense of ikigai. For instance, P7, who initially felt she lacked meaningful relationships within her living facility, recounted her involvement with the Hanukkah bazaar and her longstanding connection with her temple community in detail: *"I helped with the Hanukkah bazaar, and I go to [place name] and have a good time there. But at the temple, I know more people because I've been there for 50 years."*

4) Planning: 12 older adults reflected on their plans with the robot in response to its *pre-determined question* about their plans for today and tomorrow. All 12 participants provided detailed plans. For example, P13$_{89/F}$ explained her plans: "*So next Sunday, I plan to go to church. So I will go with my friend in her car on Sunday morning.*"

After several follow-up questions, the robot's *pre-determined question* about what would bring them fulfillment and value in life allowed eight participants (67%) to reflect more on their plans and how they relate to their ikigai. For example, P13 explained to the robot in detail: *"I probably couldn't do anything else that would feel more fulfilled or valuable because then I could pray in my room about things I want to pray about. And that usually calms me down from things that bother me."*

The later *LLM-generated follow-up question* about participants' specific plans encouraged all of them (100%) to provide detailed explanations on how these plans contribute to their sense of fulfillment. For example, the GPT-generated follow-up, `"What types of things do you usually pray for when you're feeling overwhelmed?`," allowed P13 to share more about why praying is important to her: "*...I pray for a few friends of mine who are under the weather.*" This example illustrates the robot's ability to transition to specific personal topics.

5) Goal Setting: 13 participants reflected on their future goals with the robot. The conversation was initiated by a *pre-determined question* about their monthly goal. This question let 10 participants (77%) offer detailed responses about their personal endeavors and aspirations. For instance, P8$_{81/M}$ reflected on the significance of family, stating in detail, "*I would probably be looking at my family, my children, and grandchildren and encouraging them in terms of their work and the development that they're involved in.*"

After the initial question, the robot used *LLM* to generate engaging, tailored *follow-up questions* for 11 participants (85%), enhancing the dialogue's depth. For example, after discussing plans, the robot asked, "`That sounds like a great plan. What specific activities do you plan to do with your family in the next month to encourage them?`" This led P8 to share his encouragement method: "*knowing that they have challenges that they would be dealing with and they will continue to have my support.*"

Reflecting on future plans and visualizing celebrations ended with a *pre-determined follow-up question* about how they felt after considering the prospect of achieving it. This

allowed the participants to strengthen their reflection of future goals into something visualizable. For example, P8 remarked, "*Hopefully I'll have some smiles*." P8's example illustrated how the robot's questions allowed him to transition from general support for his children and family to the specifics of encouragement methods and, ultimately, how these actions contribute to his internal happiness.

B. What the robot could improve

Not all pre-determined questions were clear and straightforward enough for participants, resulting in their giving *simple affirmations* or expressing *uncertainty* or *disengagement*.

1) Vague and unclear pre-determined questions: Some questions were not clear for the participants. For example, the questions in the social interaction topic that asked the participants to "share their thoughts" were not engaging. Open-ended questions without detailed instructions resulted in seven of our participants (43%) not engaging with the robot's request to share their reflections. As $P9_{82/F}$ quickly responded: "*I think we can go on to the next thing*."

In the planning topic, the robot's third set of questions asking participants to schedule a calendar reminder for their plans was tricky for participants to envision with the robot. Only three participants agreed to create reminders in the calendar (25%), two participants did not understand what the robot meant (17%), and seven participants (58%) refused to schedule. For instance, $P8_{81/M}$ and $P15_{82/M}$ said they had existing methods for organizing their schedules, indicating that the proposed calendar feature was unnecessary for their planning needs. Other times, certain activities do not require reminders. For example, when the robot asked $P19_{70/M}$ if he needed a reminder for his task of organizing his shelf, he responded, "*No, I've been planning [on organizing the shelf] for a while*."

2) Providing memory cues when a person can't remember: While the robot's questions were designed to guide participants toward reflecting on aspects of their lives that contribute to their ikigai, times when they could not remember relevant events revealed a limitation of the current robot's design. For example, two participants could not engage in the conversation the robot prompted about accomplishment (12.5%) because they could not think of what they had done. Despite this challenge, assistance from family members or care partners helped with the conversation flow. For example, $P5_{95/F}$, living with dementia, struggled to articulate achievements until prompted by her daughter-in-law:

ROBOT: `...What are some things that you have accomplished in the last week that you are proud of?`
MODERATOR: Did you reach any goals last week?
DAUGHTER-IN-LAW: Did you win any card game?
P5: I can't remember.
MODERATOR: You said you have.
DAUGHTER-IN-LAW: I think you have to because, as it [care-partners] said, you won at bingo.
P5: I like to win anything.
DAUGHTER-IN-LAW: You're good at games.
P5: (talking to the robot) She says I'm good at playing games.

With the daughter-in-law's hint of a win at bingo, P5 could continue reflecting on recent accomplishments.

Similarly, a care partner reminded $P4_{80/M}$, who is also living with dementia, of his accomplishment in running a company when he could not recall any of his achievements. This memory cue helped P4 continue the conversation about his accomplishment, which could be a significant element in his ikigai.

C. Mixed feedback on overall interaction

Participants provided mixed feedback on their interactions with the robot in the survey. It was evaluated on a Likert scale of one to five, with one being strongly disagree and five being strongly agree. Factor analysis grouped the survey questions into four factors: 'communication clarity,' 'facilitating reflection,' 'backchanneling methods,' and 'physical movements' (see Table III). Altogether, all four factors explain 0.76 of the variation in the data.

The robot's communication clarity (factor 1) was rated with a mean score of 3.57 (SD=1.09, Cronbach's alpha=0.93, skewness=-0.88), indicating moderate satisfaction. The robot's ability to facilitate reflection (factor 2) had a slightly lower mean score of 3.31 (SD=1.01, Cronbach's alpha=0.89, skewness=-0.40), suggesting room for improvement. Backchanneling methods (factor 3), which include response timing and auditory cues, received a higher average score of 3.92 (SD=0.76, Cronbach's alpha=0.92, skewness=-0.67), and the robot's physical movements (factor 4) were similarly well-received with a mean score of 3.89 (SD=0.88, Cronbach's alpha=not applicable, skewness=-0.34).

The mixed results align with the interview results, where $P13_{89/F}$ mentioned the robot helped them reflect on "*things important in life.*" However, enhancing ikigai through the robot presented challenges, as highlighted by $P10_{92/F}$, who noted, "*I know I'm speaking to a robot, and she doesn't know all of my inner thoughts.*" These results suggest that, while the robot's communication and physical presence were positively evaluated, its role in supporting meaningful reflection on ikigai may benefit from further enhancement.

VI. Discussion

Referencing the protocols from a previous WoZ reflection activity [1] and suggestions from a co-design panel with older adults [28], we developed an autonomous robot designed to facilitate reflection towards discovering ikigai in a semi-structured conversation. Through analyzing interactions with 19 older adults, we identified the robot's potential and areas for improvement in guiding individuals to explore their ikigai. These observations, aligning with survey responses, indicated that although the robot's communication and interactions were appropriate, participants still felt it lacked a deeper understanding, perceiving it merely as a 'robot.' There was a need for improved support in meaningful reflection on ikigai. Below, we outline the design considerations for an autonomous robot to facilitate this reflection.

TABLE III
FACTOR LOADINGS OF SURVEY QUESTIONS AND EXCLUDED QUESTIONS

#	Question	Factor 1	Factor 2	Factor 3	Factor 4	Exclude
1	Communicating with the robot was clear.	**0.816**				
2	The interaction with the robot felt like an ongoing conversation.					Y
3	The robot was able to keep track of context.	**0.878**				
4	The robot was able to ask appropriate questions.	**0.830**				
5	The robot could handle situations in which the line of conversation was not clear.		**0.854**			
6	The robot's responses were easy to understand.	**0.854**				
7	The robot understands what I want.		**0.639**			
8	The robot helps me reflect on my ikigai.		**0.745**			
9	The robot's responses were accurate.	**0.743**				
10	My waiting time for a response from the robot was short.			**0.872**		
11	I could tell when the robot had finished speaking.					Y
12	I like the robot's physical movements.				**0.966**	
13	I like the robot's facial expressions.					Y
14	The robot shows empathy.		**0.802**			
15	The robot makes appropriate sounds			**0.874**		

A. Interleaving pre-determined & LLM-generated questions

Ikigai, as a deeply personal concept, presents a challenge for developing a one-size-fits-all conversational flow. Our robot design, supported by our adaptable social robot programming framework [30], shows that integrating pre-determined prompts with LLM-generated follow-up questions can inspire in-depth participant reflections. Switching between pre-determined and LLM-generated questions provided personalization of the conversation while preventing the generative AI from leading the conversation in undesired directions. For instance, in goal setting, the robot effectively combined broad goal identification through pre-determined questions with personalized LLM-generated questions to help participants identify actionable steps they can take, creating a tailored and coherent reflection path for each participant. This combination of a pre-determined flow and individualized follow-up questions echoes strategies found in reminiscence research [22], [21] and showcases how a balanced dialogue structure led by the robot can help individuals reflect on their ikigai.

B. Being simple yet specific in ikigai questions

Vague and general prompts the robot gave participants often led to short and uncertain responses or disengagement. Participants were particularly confused when the robot asked them to "`share their thoughts`" following a 10-second visualization on social interaction or when the robot asked them if they wanted to set a reminder on their calendar. These questions could be made more simple and specific. For example, when asking participants to share their thoughts, the robot could add more details of the thoughts they want the user to share. For setting calendar reminders, the robot should clearly explain how it will access users' calendars and set reminders.

C. Using the robot to provide memory cues

The involvement of a daughter-in-law or care partner for participants P5 and P4, when they struggled to remember responses to ikigai-related questions, highlights the potential for robots to aid individuals who struggle to recall past events. For example, within an aging care facility, a robot could recommend engaging in specific activities or setting achievable goals that resonate with the individual's current situation, thereby avoiding emphasis on any perceived absence of ikigai. This role could extend to remembering earlier conversations or understanding the individual's environment, helping reframe notions of meaninglessness and discovering ikigai. Rather than solving the challenge, the robot could also recommend that older adults connect with family members, strengthening their bonds, as suggested in a prior study [25].

VII. LIMITATIONS AND FUTURE WORK

This study suggests several opportunities for future work. The focus on robots in a conversational context provides potential for future studies to explore how additional factors like robot embodiment, non-verbal cues, movement, and the interaction context impact the interaction. Additionally, as the current analysis focused on transcripts of participants' conversations with the robot and their response levels, future research could explore other measures of participants' ikigai. Future research could also explore the long-term impact of robot-supported reflection on older adults' sense of ikigai.

VIII. CONCLUSION

In this research, we designed an autonomous robot to support older adults in contemplating their life's purpose, building upon insights from a previous WoZ prototype [1] and feedback from a longitudinal co-design panel with older adults [28]. Iterations of this robot's design enhanced conversation with direct prompts, asked follow-up questions connected to participants' answers, and improved engagement in five topics related to ikigai. Through conversation and survey analysis of the interaction with 19 older adults, we suggested several elements essential for an autonomous robot for reflection activity. Notably, using our social robot programming framework [30] with simple yet specific *pre-determined* questions and *LLM-generated follow-up questions* (using GPT) in the prompts, the robot initiated discussions that nudged the participants towards detailed reflection on their life's meaning. Additionally, we recognized the importance of the robot offering suggestions when participants felt a sense of lack of meaning in specific topics in life. Among the

complexities of aging, such an autonomous robot could guide individuals toward discovering their ikigai—their reason for being— by starting reflections with the suggestion, "*Let's talk about you.*"

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