

Robotic utterance style to promote conversation with older people in Japan

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M. Hirano, K. Ogura, D. Sakamoto, M. Nakano, T. Tsuchida, Y. Iwano, H. Shimoyama. Robotic utterance style to promote conversation with older people in Japan. Gerontechnology 2019;18(2):89-96; <https://doi.org/10.4017/gt.2019.18.2.003.00> **Background** Many studies indicate that companion robots are effective for supporting the health of older people have been reported; however, there is little knowledge on supporting older people through conversation. It is thus necessary to explore the conversation style of robots to promote the psychological health of older people. **Research aim** The aim of this study was to explore which style of robot's utterance was effective for promoting relationship with older people: provide useful information or only ask questions and provide neutral responses. **Methods** We conducted a comparative study using two talking robots with the aim of promoting psychological health. One robot has programmed to converse frequently with people, giving them general advices; the other robot was programmed listen frequently to people. Twenty-nine participants (average 70.28 years old) were randomly divided into two groups, and after having a semi-structured conversation with the robot, they responded to an impressive evaluation and interview. **Results** The results showed that there was a significant difference between the two groups; the number of utterances of participants in the listening-robot group was significantly higher than that of the speaking-robot group. We analyzed the conversation content, and the results showed that participants had a more positive feeling toward the listening robot than toward the speaking robot. **Conclusion** We argue that social robots for older people should listen more than speak in order to promote a better relationship.

Keywords: companion robots, conversation, promoting mental health

INTRODUCTION

There is an increase in the older population, and hence, the promotion of health and quality of life of older people is an important issue. Therefore, robots to support the psychological and physical health of older people have been widely researched in the field of robotics and human-robot interaction to promote the health of older people. A review by Robinson et al. (2014) identified that the scope of the application of robots extends not only to physical support and health management of disabled people, but

also to facilitate communication between people and social robots, to prevent loneliness and promote psychological health. These social robots have been developed to promote psychological health by facilitating communication. The most typical example of helping older people communicate with one another is to facilitate communication with distant families (Mickus & Luz, 2002). Companion robots have been developed to communicate with people directly. Paro (Shibata, 2012) and AIBO (Kanamori et al., 2002) are major examples of animal-like companion

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robots, which have been used for psychological health promotion research; these robots were confirmed to have a positive effect on communication. The effect was particularly significant in communication with older people (Nakata et al., 1996). These robots however do not have verbal communication or conversation functionalities; they were developed to promote psychological changes simply through their presence and to give visual and haptic reactions to older people. Although these robots had a significant impact on health-promotion research, there were no typical examples of social robots utilizing conversation as a means to provide meaningful information and promote psychological health. There have been studies on a robot speaking to a group of people, more precisely in a nursing home, such as a nursing care facility (Matsuyama et al., 2009; Toyoda et al., 2012). Improving the conversation function of a social robot to promote the quality of life of elderly people has become an important issue recently.

Older people desire interactive communication with social robots (Kuo et al., 2009). A study that analyzed chats between an older person and a communication robot showed that speech and dialogue technology, especially as speech recognition rates improve, does not increase the number of dialogues (Sato-Shimokawara et al., 2006).

The ability of people to converse decreases as they age due to deterioration in hearing and working memory (Just & Carpenter, 1992), therefore, slow, short, and simple utterances and typical prosodic speech will be simpler for older people to recognize (Wingfield & Stine-Morrow, 2000). However, it has also been shown that such “elderspeak” is not effective in understanding a conversation (Kemper & Harden, 1999), leading to a decrease in the cognitive function and independent-mindedness of older people (Ryan et al., 1995). Although older people have decreased cognitive function, it has been shown that they maintain conversations by gauging the context using vocabulary and knowledge accumulated through life experience (Kemper & Sumner, 2001). In studies investigating dialogue with a robot to observe how a robot’s utterance timing influences their impression, older people showed a diverse interpretation of the robot’s behavior and utterances compared to young people (Takasugi et al., 2010).

Based on this literature review, when considering the effective development of a conversational robot for older people, improving the accuracy of the robot’s utterance content does not necessarily increase the satisfaction of elderly users, and it may not necessarily provide psychological support. According to the Communication

Predicament of Aging Model (Ryan et al., 1995), older people will avoid conversation when provided with limited topics and instructive speech.

We hypothesize that it would be better for a robot to not actively speak to older people; rather, it would be better if the robot proactively listens to what older people say to promote psychological health. To test this hypothesis, we conduct an experiment to compare two robots:

- (1) A robot that speaks fluently and actively, and provides qualified useful information about psychological health.
- (2) A robot that does not provide useful information but only asks questions and provides neutral responses, such as “*huh*”.

We examined which type of robot behavior facilitates more humanistic conversation between older people and the robot and which robot has a more positive effect.

METHODS

We conducted a comparative study of two types of robot that frequently speak or listen to people to understand the difference in these two behaviors of a social robot. This study was received approval from a research ethics committee at an affiliated institution.

Participants

We recruited 29 volunteers (10 males and 19 females) through paper flyers. Their mean age was 70.28 ($SD=5.22$); 24% lived alone, 41% lived with spouses, 24% were two-generation families, 10% were three-generation families, 17% lived with companion animals, 14% have used cleaning robots before, and 17% had experience in talking with robots. We focused on older adults to keep the study simple and to eliminate generation differences. This is the same situation as in the *Paro* experiment (Robinson et al., 2013). All participants provided written informed consent and agreed to volunteer their time to research.

Talking clearing robot

We used a COCOROBO RX-V200 talking cleaning robot made by Sharp Corporation (Figure 1). The robot was originally designed as a cleaning robot with talking capability, so it can speak and listen. Not only users can ask the robot to clean the room by voicing command, they can also ask questions about the weather and the robots’ mood, for example. However, to keep interactions simple and to focus on the comparison of the robots’ behaviors, we reprogrammed the COCOROBO system to have limited vocabulary for conversation. Both speaking and listening robots had the same vocabulary: (a) twenty-eight kinds of general utterances including greetings (e.g., “hello”), simple question (e.g., “*where are you from*”).

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Figure 1. COCOROBO talking cleaning robot

today?”), and general responses (e.g., “it’s good”, “I’m happy”, etc.), (b) twenty kinds of responses according to a conversation list, which we provide to participants, (c) eighteen kinds of responses according to the participant’s health condition, (d) sixteen kinds of general advice to user about mental health. However, in addition to the general response to participants, the speaking robot could give advisory comments and the listening robot could give ambiguous responses such as “huh”. We used the Woz method so that the robots would be able to respond to people quickly, correctly, and appropriately rather than fully automatic interaction mode. In this experiment, one trained experimenter who has 10+ years of experiences of operating communication robot, operated the robot for all experiments. A simple user interface was developed for this Woz experiment. There are multiple buttons corresponding to all utterances (a) to (d) and the ambiguous response “huh”, and a robot speaks if an experimenter selects a button on it. The experimenter selects a robot’s utterance to make the conversation as natural as possible. Duration of conversation and response from the robot was controlled to be con-

sistent for all participants; the experimenter was trained to keep the response time as same as possible with the automated version of COCOROBO system. The utterances of (c) and (d) were used according to the experimental group.

Study setup

The purpose of the study was to examine which robot (listening or speaking) is able to lead more utterance from the older people and brings positive feelings to the robot. While designing the same concept of promoting the psychological well-being of the elderly, we designed two types of robots: speaking robot and listening robot. Speaking robot was designed to speak general advice to become psychologically healthy and listening robot was designed to listen to user’s speech. Participants were randomly divided into two groups; listening-robot group ($n=14$) and speaking-robot group ($n=15$). The task was a simple semi-structured conversation with the robot but with no restrictions, the same as in the Paro experiment (Robinson et al., 2013). Participants were asked to address the robot by saying words on a list we prepared. We wrote sixteen patterns on the list and told the participants that the “words on this list are generally acceptable for robots. But you are not limited to these words”.

Table 1 shows the procedure of this study. Once a participant comes into the room, one of our staff members explains the study and function of the robot. Next, we ask him/her to give the robot a greeting and start free conversation. As participants are the first to talk to the robot, they were given a list of words that the robot could recognize (e.g. “Nice to meet you.” “Good morning.”), and they tried to speak the words in the list. At step #3, the two robots behave differently; both robots respond to the same words that are on the list. However, if a participant speaks using unlisted words, the listening robot chimes in using such utterances as “huh?” and listens thoroughly. In contrast, the speaking robot gives verbal advice to promote health, such as “You can feel relaxed by taking a deep breath”. After that, participants talk with the robot freely for a while and the study ends. The study was conducted in a room with a sofa. A staff member waited in the room and facilitated the pro-

Table 1. Procedure of study

	Listening robot group (n=14)	Speaking robot group (n=15)
Procedure of study (15 min)	#1. Greetings / Explanation	
	#2. Free talk with list of words	
	#3. Robot requires user to talk about his/her condition	#3. Robot gives general advice to user about mental health
	#4. Free talk	
Robots’ responses to unlisted words	Robot chimes in and listens to user talking	Robot talks about promoting health

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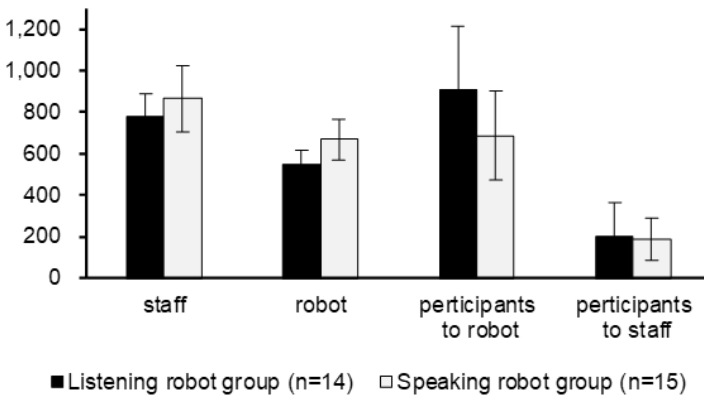


Figure 2. Number of utterances

cedure. We considered the mental and physical burden of the elderly and set the experiment time to about 15 minutes.

Data collection

All the conversations and participants' behaviors in the experimental room were video-recorded and transcribed. We categorized the participants' utterances by similarity of meaning in the context of the conversations. When an utterance corresponded to different categories, it was coded for all those categories. We also collected subjective data from when the participants evaluated their interaction experience with the robot. We used an 11-item questionnaire using a semantic differential (SD) scale. In addition to the questionnaire, 15–30-minute interviews were conducted by two staff members. We asked about their impression of the robots and their evaluations of the robots' functions.

This study was received approval from The University of Tokyo / Office for Life Science Re-

Table 2. Categories of utterances

	Frequency		Frequency
Question	338	Repeat robot's words	92
Accepting	242	Say robot's name	80
Greeting	190	Laughing	77
Compliment	165	Request	64
Feeling	160	Self-disclosure	59
Reply	124	Mental state	41
Seek agreement	112	Suggestion	26
Appreciation	109	"I'm sorry"	5
"Thank you"	107	Others	14

search Ethics and Safety (Approval number: 14-1569).

RESULTS

Number of utterances

We first compared the number of utterances from participant to the robot (Figure 2). The number of utterances was calculated based on the transcribed word count. As a result, participants in the listening-robot group spoke more often to the robot than those in the speaking-robot group ($t(27) = 2.23$, $d = .81$, $p = .03$). We also compared the number of utter-

ances from the robots. A t-test showed that the speaking robot spoke significantly more ($t(27) = 3.74$, $d = -1.35$, $p = .00$). Finally, we conducted another t-test to confirm that the number of utterances when participants conversed with the staff did not affect the overall results. There was no significant difference between the two groups ($t(27) = -1.68$, $d = .61$, $p = .10$).

Content of conversation

Next, we compared the participants' utterances to examine how the interactions with the robots differed between the two groups. We categorized the participants' utterances according to the method mentioned in the Data Collection section; we determined eighteen categories (Table 2), and principal component analysis was used to fourteen categories which appeared more than fifty times. We identified five components of conversations: Open communication, Request and Appreciation, Acceptance, Ask for a reply, and Reply. The cumulative proportion was 64.43% (Table 3). We compared the average of each principal component scores in the two groups using MANOVA ($F(5, 23) = 7.48$, $\eta^2 = .62$, $p = .00$). As a result, the content of participants' utterances were relatively "Acceptance" and "Ask for a reply" in the speaking-robot group (Acceptance: $F(1, 27) = 6.02$, $\eta^2 = .18$, $p = .02$, Ask for a reply: $F(1, 27) = 4.71$, $\eta^2 = .15$, $p = .04$). On the other hand, we observed that the content of utterances of participants in the listening-robot group were more along the lines of "Open communication" that involves self-disclosure or express feelings ($F(1, 27) = 9.65$, $\eta^2 = .62$, $p = .00$) (Table 4).

Impression of robots

First, we conducted an exploratory factor analysis using the principal

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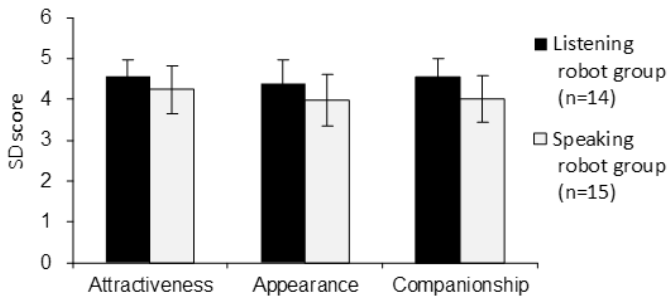


Figure 3. Results of questionnaire

factor method and Promax rotation for the items (Table 5). Three factors were extracted and internal consistency were confirmed ($\alpha=.71 - .81$). We compared summary scores of each factors between two groups (Figure 3). The result showed listening-robot group received higher scores than the speaking-robot group in all factors, especially in the factor of “companionship” (Attractiveness: $t(27)=1.77, d=.64, p=.09$, Appearance: $t(27)=1.80, d=.65, p=.08$, Companionship: $t(27)=2.85, d=1.03, p=.01$).

Interview

All interviews were transcribed and categorized according to the conversation content. We found similarities and differences between the two groups. First, participants in both groups answered that they felt the robots were cute, i.e., “its tone of voice was cute” (P3), “[it’s] cute when it is cleaning” (P25), and warm, i.e., “the responses were kind” (P4), “The wording was warm” (P21). In addition to the tone of voice and movement, the content of utterances of being unstrained and soothing gave the participants the impression of

the robots being cute.

Looking closer at the listening group, participants were more satisfied with their expectations of the robot [stands by and is emotionally responsive] than with the conversational function, i.e., “if it is a sick person and he/she is sleeping, it is better to sleep together with the robot” (P15). On the other hand, participants in the speaking-robot group complained that they want-

ed the robot to use a more varied vocabulary and did not seem satisfied with the robot, i.e., “I wanted the robot to use more words when I said to the robot ‘I am lonely now’” (P21). Even though the listening robot spoke less than the speaking robot, there were no responses about the participants in the listening-robot group wanting the robot to use more words.

We also focused on the feeling of human-likeness in the listening-robot group, i.e., “[regarding the content of the robot’s self-talk] it was similar feeling with me” (P5), and “soon it won’t be a machine to me” (P29). On the other hand, participants in the speaking group commented on wanting more emotion from the robot, i.e., “[I] got replies from the robot, but it lacks emotion” (P9), “[it is] a little bit difficult to expect that the robot can read our mind” (P19). Listening behavior would give an impression of human-likeness; however, it was suggested that referential advice from the robot would be considered a machine-like response.

Table 3. Component matrix of categories of utterances

		Principal component				
		1	2	3	4	5
C1: Open communication	Say robot's name	.84	-.29	.05	.00	.08
	Self-disclosure	.81	.16	-.20	-.23	-.17
	Feeling	.73	-.20	.12	-.18	-.01
	Compliment	.64	-.38	.30	-.18	-.29
	Repeat robot's words	.48	-.34	.00	.15	.27
C2: Request and Appreciation	Request	.23	.65	.42	.33	-.09
	"Thank you"	.39	.63	-.06	-.08	-.10
	Appreciation	.48	.60	.00	.04	-.04
	Greeting	.19	.52	.09	.21	.44
C3: Acceptance	Accepting	-.04	-.15	.73	.44	-.23
	Laughing	-.25	.26	.72	-.36	.05
C4: Ask for a reply	Question	.15	-.48	.22	.52	.12
	Seek agreement	.26	.08	-.31	.44	.39
C5: Reply	Reply	.02	-.12	.39	-.46	.69

Finally, we focused on the effect of chiming in. For the chiming in of “huh”, participants commented that “I thought it was thinking” (P17), and “it was like in two minds” (P17). They interpreted the robot’s behavior as it was thinking of something by understanding what was said. “When the robot did

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Table 4. MANOVA with principal component score between two groups

	Multivariate test					Listening		Speaking		df	SS	F	η^2	p
	V	F	df	η^2	p	Mean	SD	Mean	SD					
	.62	7.48	5, 23	.62	.00									
C1: Open communication						.52	.23	-.49	.23	1	7.37	9.65	.26	.00
Error											27	.76		
C2: Request and Appreciation						.14	.27	-.13	.26	1	.50	.49	.02	.49
Error											27	1.02		
C3: Acceptance						-.43	.25	.41	.24	1	5.11	6.02	.18	.02
Error											27	.85		
C4: Ask for a reply						-.39	.25	.36	.24	1	4.16	4.71	.15	.04
Error											27	.88		
C5: Reply						.09	.27	-.08	.26	1	.21	.20	.01	.66
Error											27	1.03		
Total											29	28		

not reply with 'huh,' it made me worry that it did not recognize my voice" (P27). For the speaking robot, we observed that "I was not completely sure when I should reply" (P25). This suggests that the chiming in behavior seems to work as a delimiter of communication.

DISCUSSION

Differences in communication between the two groups

We confirmed that there was a significant difference in the number and quality of utterances by participants. Participants in the listening-robot group were able to speak more about their feelings

and provided more information about themselves than those in the speaking-robot group. In addition, the listening-robot group had a significantly positive impression of the robot as a companion. The same result is also obtained through the interview; participants were more satisfied with and sensed the human-likeness of the robot in the listening-robot group. From these results, it is suggested that the listening robot is more readily recognized as an appropriate communication partner compared to the speaking robot. Although older people have been found to tend to avoid emotional scenes (Lawton et al., 1992), it is important for them to express moderate emotions for their psychological health (Consedine et al., 2005), and the promotion of emotional expression through communication with robots may promote the mental health of older people.

Differences in relationship between the two groups

The results of the qualitative differences of utterances and impressions of the robot suggest that the relationships between the robots and participants were completely different in the two groups. As mentioned above, the participants in the listening-robot group tended to speak to the robot about their feelings and information about themselves. On the other hand, participants in the speaking-robot group tended to listen to what the robot said and accept. This inversion phenomenon has important implications in the design of home robots; the frequently speaking robot was recognized as an advisor with an authoritative image, and the frequently listening robot was recognized as being cute, safe, and warm.

Older people are recognized as "people who need help" or "people with limited ability" from their surroundings, and are likely to

Table 5. Factor matrix of SD scale

		F1	F2	F3
Attractiveness ($\alpha=.80$)	Unworned	.93	.10	-.11
	Want to speak to	.60	.04	-.11
	Friendly	.60	.13	.20
	Lovely	.44	.11	.04
	Want to control	.32	.10	.28
Appearance ($\alpha=.71$)	Cute	.19	.78	-.13
	Look at it longer	.13	.71	.19
	Want to touch	-.06	.37	.13
Companionship ($\alpha=.81$)	Want to be with it	-.29	.28	.86
	Like	.50	-.36	.64
	Want to be involved	.15	.28	.55
Correlation	F1		.54	.65
	F2			.52

be spoken to instructively or placed in a weak position [13]. In such a situation, although older people can receive support, they are more likely to lose their dignity. In a study that analyzed the conversation between a care worker and an elderly person, a communication pattern was reported in which the older person “accepts” offers from care workers (Akiya, 2009).

Furthermore, in this research, there were significantly more utterances of “acceptance” to the speaking robot. In other words, in the conversation with the robot, there is a possibility that the “accepting” communication pattern of older people is reproduced by the robot speaking too much. We strive to make the robot “listen” to the elderly person’s story, so that they can perceive the communication of the robot as a companion; that is, the relationship maintains the dignity and independence of older people. We believe that this relationship will contribute to the psychological health of older people.

Effectiveness of ambiguous chiming

Ambiguous chiming as a response for expressing listening behavior in the listening robot contributed to continuous communication and elicited participants to speak. For the listening-

robot group, participants interpreted that the robot was thinking when they heard the “huh” chime from the robot. The “huh” sound is a neutral response; it is neither positive nor negative. Ambiguous chiming made the robot a “listening robot” to enable natural conversation with people. This result seems to be successful in effectively utilizing “top-down processing” (Lindsay & Norman, 2013), which is a feature of the language function of elderly persons, that is, the feature of supplementing by supposing the portion where cognitive processing has deteriorated.

Limitation

In this study, a lot of qualitative data could be obtained from precious samples such as the elderly people; however, the small sample size was a limitation. Furthermore, the conversation was conducted in an experimental scene, which is an unusual space. In future research, it is necessary to examine a conversation style that forms a relationship for generating psychological support for elderly people by acquiring more long-term conversation data in the subjects’ everyday situation. In addition, we need to consider whether the results observed in Japan can be applied to people in other cultures.

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