International Journal of Social Robotics
https://doi.org/10.1007/s12369-025-01229-2

Impact of Table-Top Robots on Questionnaire Response Rates at a Science Museum

Taiga Natori[1] · Takamasa Iio[2] · Yuichiro Yoshikawa[1] · Hiroshi Ishiguro[1]

Accepted: 7 February 2025

Abstract
To facilitate the integration of robot applications in real environments, evaluating whether or how much the presence of a robot entity influences human behavior is important. In addition, it is necessary to evaluate the influence of voice-only systems, which can be implemented more easily than robots. Therefore, in this study, we conducted two experiments to evaluate the visitor behavior at a science museum when requested to respond to a questionnaire under one of three different conditions (Robot, Audio, or None). The results indicated that using the robot improved the response rate more than using the audio alone or with no intervention. Audio intervention also increased the response rate compared with no intervention. While the robots increased their number of responses, there was a trend toward an increase in emotional responses rather than opinions in the free-response descriptions. These results are important for promoting the future use of robots.

Keywords Social robot · Service robot · Human–robot interaction · Field trial

1 Introduction

1.1 Background

Several studies have been conducted on social robots that assist or replace people in their daily lives (Table 1). For example, robots have been used for providing directions and advertisements in shopping malls [1–4], as guides in museums [5], teachers, and students' peers in educational settings [6–8], conversation partners in private spaces such as homes and hospital rooms, and concierges in hotels [9–13]. Considering the declining working population worldwide [14], social robots providing such services are increasingly expected to play an important role in the society.

To promote the social implementation of robots that influence people's behavior through interactions, researchers should promote Evidence-Based Practice (EBP), which uses scientific evidence to determine what to do next, as is often performed in day-to-day patient care and clinical practice. This is required for the efficient use of taxpayers' money in the health and welfare fields [15–17]. The concept of EBP focuses on the appropriate use of evolving technologies to increase safety and effectiveness rather than adhering to traditional methods. EBP has been adopted in a wide range of fields, including policymaking [18], intervention methods for poor families [19], and education [20]. Similar fundamentals are required with the daily use of robots. Therefore, even for social robots that aim to promote changes in human behavior, researchers must quantitatively demonstrate the extent to which robots can promote changes in human behavior in a real-world setting.

However, existing research on promoting changes in human behavior by social robots in real-world settings has often not included quantitative comparisons with or without the use of robots (refer to Table 1). This is particularly true for autonomously operating robots. Okafuji et al. conducted an experiment in a shopping mall to investigate how robots call out to passersby to start an interaction and compared this

✉ Taiga Natori
natori.taiga@irl.sys.es.osaka-u.ac.jp

Takamasa Iio
tiio@mail.doshisha.ac.jp

Yuichiro Yoshikawa
yoshikawa@irl.sys.es.osaka-u.ac.jp

Hiroshi Ishiguro
ishiguro@irl.sys.es.osaka-u.ac.jp

1 Graduation School of Engineering Science, Osaka University, 1-3, Machikaneyama-cho, Toyonaka, Osaka 560-8531, Japan

2 Faculty of Culture and Information Science, Doshisha University, 1-3, Tataramiyakodani, Kyotanabe, Kyoto 610-0394, Japan

Published online: 01 March 2025

Table 1 Empirical studies of social robots that interacted with people in wild spaces

Main Purpose	Term	With/Without	Autonomous	Public	Place
Advertisement [1]	10 days		✓	✓	Shopping Mall
Advertisement [2]	4 h * 3 days	✓		✓	Shopping Mall
Guide [5]	2 months		✓	✓	Science Museum
Education [6]	20 min * 7 days	✓		✓	School
Dieting [9]	6 weeks	✓	✓		Home
Hospital Care [11]	9 h * 15 days		✓	✓	Hospital
Hotel Service [12]	6 months		✓	✓	Hotel
Receptionist [13]	180 days		✓	✓	College
Request for Answer (this paper)	7 h * 27 days 6 h * 10 days	✓	✓	✓	Science Museum

with when people call out to robots [1]. They demonstrated that the interaction started more when the robot asked for help than when it was greeting or dancing. This had a similar effect to when a person called for help. However, they did not conduct a quantitative comparison with and without a robot. Conversely, Shiomi et al. conducted an experiment in a shopping mall to determine whether interaction with passersby begins with or without a robot [2]. The results showed that more interactions were initiated with a robot next to a display than without a robot. However, the robot was operated semi-autonomously by an operator. Therefore, it is unclear to what extent robots operating autonomously in public spaces affect the promotion of changes in human behavior compared with cases without them.

1.2 Research Objective

Building on this background, we formulated the primary objectives of this study. The first goal was to quantify the behavioral changes induced by introducing a social robot that operates autonomously in public spaces. In particular, we focused on implementing social robots in science museums and exhibitions. Velentza et al. investigated using voice-guided tours and robotic guides in these environments [21]. However, their study did not compare scenarios with and without guided assistance. Furthermore, although Shiomi et al. conducted long-term studies on interactions during robotic-guided tours, they did not provide extensive quantitative comparisons [5]. This highlights a general gap in the literature, in terms of the scarcity of quantitative data in evaluating the effectiveness of robotic interventions, especially in contrast to no- intervention scenarios. Our research aims to address this gap by providing comprehensive data that evaluates whether introducing robots in museum settings is beneficial. To investigate these aspects, we utilized a methodology involving a questionnaire survey, a widely employed tool in various studies, to examine the quantitative effects.. However, many large commercial and public facilities, such as science museums, shopping malls, and hospitals, rely on questionnaires placed in areas frequented by visitors as their primary means to gather customer feedback [20]. In contrast to this passive method, this study attempted to collect feedback more actively by using an autonomously operating social robot.

Our second goal was to quantify the effect of the presence of a social robot on promoting changes in human behavior by comparing the voice calls made by the robot with those made by a loudspeaker. This goal answers the question, “Is only voice insufficient?” This issue is frequently discussed in the field of social robotics. If the effects of calling with physical actions using a robot and voice-only calling using a loudspeaker are similar, then using a less expensive loudspeaker would be preferable.

Two field experiments are conducted to achieve these goals. The remainder of this paper is organized as follows: Sects. 2 and 3 describe experiments 1 and 2, respectively. A general discussion is presented in Sect. 4. Finally, Sect. 5 concludes the study.

2 Experiment 1

2.1 Purpose

This experiment aimed to assess the influence of a robot and loudspeaker on individuals’ responses to a questionnaire. The study involved comparing participants’ behavior when prompted by either the robot or loudspeaker as well as in the absence of both stimuli. The experiment was conducted for 21 days at a science museum in a local Japanese city. A robot and loudspeaker were positioned in a corridor within the exhibition hall to administer the questionnaire and solicit responses. The effects of the robot and loudspeaker were analyzed based on the number of collected sheets.

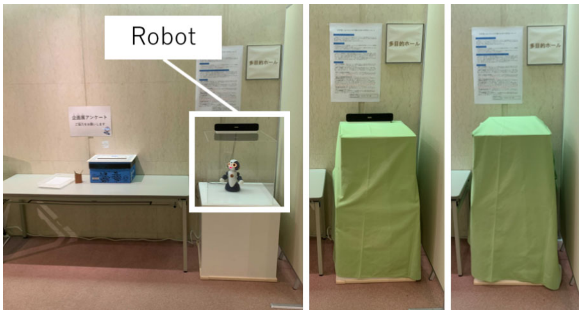


Fig. 1 Condition (From left to right: Robot condition, audio condition, and none condition)

2.2 Experimental Methods

2.2.1 Participants

The participants were visitors to the Tsukuba Expo Center Science Museum exhibition hall. Infants with difficulty answering the questionnaire were excluded from the comparison. The total number of participants was 8644.

2.2.2 Conditions

To achieve our experimental goals, we created three conditions: robot, audio, and none (Fig. 1). The details of the conditions are as follows.

Robot condition: Here, a robot and loudspeaker coexist within an area and request passersby to answer the questionnaire. The robot uses a mixture of vocal cues from a loudspeaker and accompanying gestures to elicit responses from passersby. The details of this behavior are described in the system section.

Audio condition: Here, a loudspeaker is placed in the area, which requests passersby to answer the questionnaire. Only voice calls are made, with the same content as in the robot condition.

None condition: This is the normal condition with no calls. This condition was used as the baseline for comparison.

To elucidate the effect of the three conditions on the number of responses, we employed the evaluation criteria for the Alternating Treatments Design [22] established by the What Works Clearinghouse (WWC).

Alternating Treatments Design This method determines the condition exerting the most pronounced effect by periodically switching among conditions and has garnered extensive usage in applied behavior analysis [23, 24]. The design adeptly counters the order effect intrinsic to interventions and is ideal for scenarios where ensuring the independence of participants becomes untenable, such as when an individual engages in multiple sessions. Given this context, the alternating treatments design has emerged as a potent experimental method for situations akin to the present study.

WWC.

WWC Criteria We adopted the guidelines from the What Works Clearinghouse (WWC) to enhance the validity and reliability of our experimental design [25], particularly due to the lack of clearly articulated evaluation criteria in robotic engineering research. The WWC provides rigorous standards for evaluating research designs, including the Alternating Treatments Design, which is suitable for our study.

The WWC's criteria for an alternating treatments design are as follows:

1. Systematic Manipulation of the Independent Variable

The researcher systematically manipulates the independent variable, determining when and how the conditions change.

2. Repeated Measurement of the Outcome Variable

The outcome is measured systematically over time by multiple assessors, with interobserver agreement collected for at least 20% of the data points in each phase and condition, meeting minimum thresholds.

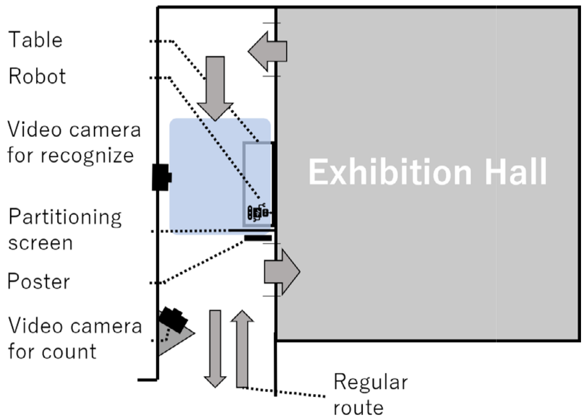
3. Sufficient Data Points and Alternation of Conditions

Each condition must have at least five data points, and the conditions are alternated without a predictable pattern to prevent order effects.

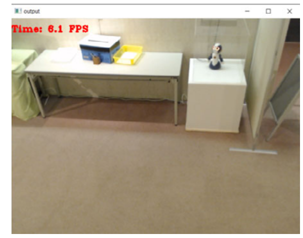
Our study was designed to meet all these criteria. We predetermined the experimental conditions (robot, audio, none) and systematically alternated them according to a fixed schedule, ensuring the systematic manipulation of the independent variable. We collected objective data and had multiple evaluators assess subjective data, calculating interobserver agreement for over 20% of the data points to ensure reliability. Each condition included more than five data points, and we alternated the conditions in a counterbalanced order to prevent order effects. By adhering to the WWC criteria, we enhanced the credibility and validity of our experimental design.

2.2.3 Experiment Schedule

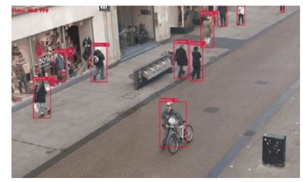
The experiment was conducted for 21 days, seven days for each condition, for 430 min daily from 9:50 a.m., when the science museum opened, to 5:00 p.m., when it closed (Table 2). The three conditions were randomly rearranged during the experiment every three days based on the alternative treatments design.



(a) Diagram of the environment



(b) Environment of the field trial



(c) Recognition image

Fig. 2 Environment of Experiment 1

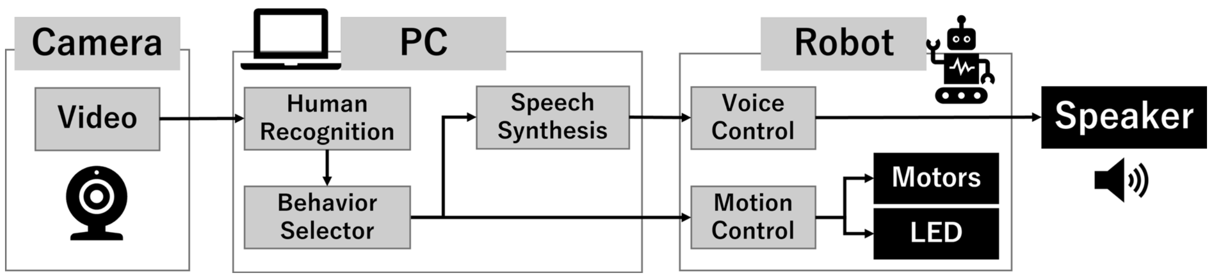


Fig. 3 System configuration. The input is the camera's video feed. For the Robot condition, the output includes Motors, LED, and Speaker. For the Audio condition, the output is the Speaker only

Table 2 Assignment of the conditions on a schedule

Sat	Sun	Mon	Tue	Wed	Thu	Fri
7/17	18	19	20	21	22	23
Robot	None	Closed	Audio	None	Robot	Audio
24	25	26	27	28	29	30
Audio	Robot	None	Robot	Audio	None	Robot
31	8/1	2	3	4	5	6
None	Audio	None	Audio	Robot	Audio	None
7						
Robot						

2.2.4 Environment

The experiment was conducted within a corridor in front of an exhibition hall (Fig. 2a). The exhibits were also lined up. This corridor is one-way, and almost all visitors to the exhibition pass through it.

Next to the last exhibit in the sequence, a desk was set to allow visitors to answer a questionnaire about the exhibition. Answering the questionnaire was not compulsory and was done anonymously. No compensation was provided. An acrylic case for the robot (Sota) was placed next to the desk for answering the questionnaire. The robot was placed inside the case and a loudspeaker for voice output was placed above the case. Sota has three degrees of freedom in its head, two degrees of freedom in each arm, and one degree of freedom in its body. The installed robot system operates autonomously. Details of the system are described in the next section.

Surveillance cameras were installed in the corridor to measure passersby, and posters were placed to indicate that the recording was in progress. Through the posters, visitors who declined to be filmed were informed about the corridor, and could avoid passing through the experimental environment.

2.2.5 System

An autonomous system was developed to prompt a response when a passerby was detected, and this system was used under robotic and audio conditions. A diagram of the system is shown in Fig. 3.

The system is divided into person recognition and speech phases. In the person recognition phase, images from a camera installed in front of the robot are sent to the person recognition module of the PC in real time. The person recognition module performs person recognition using the object detection algorithm YOLOv3 [26] based on the images in the blue rectangle in Fig. 2a. During this process, the coordinates and number of people in the image are measured at approximately 7 FPS (Fig. 2c).

Based on the recognition results, speech and robot motions are determined using a behavior-selector module. The robot adjusts its body and head orientations based on the location and movement of passersby. Additionally, specific gestures, such as arm movements, were synchronized with the spoken content. These integrations ensure that the robot's presence is perceived as naturally interactive [27]. The movements and speech are executed simultaneously, with audio delivered through an external speaker, and the motors and LEDs are activated in coordination with speech-related gestures.

By contrast, under the audio condition, although the robot is connected to the system, its physical movements and LED functions are disabled. The robot is visually obscured using a cloth cover, effectively reducing it to a conduit for audio output. Thus, the audio condition replicated the robotic setup without visual or interactive elements, isolating the impact of auditory cues.

Speech is programmed to occur when the number of people recognized within the shooting range changes (regardless of the increase or decrease, except when the number reaches zero). However, the number of people could be incorrectly recognized when they overlap, and the frequency of speech could increase to a point where it becomes a nuisance Therefore, the interval between utterances was set to at least 5 s.

Figure 4 illustrates the speech procedure. The initial state allows the robot to initiate speech at any time, and upon receiving image recognition results, the system determines whether to proceed to the next branch (approximately 7 times per second at 7 FPS). First, when a passerby is recognized in the experimental environment in the initial state (when the response is "Yes"), the robot proceeds to speak. The content "Hello" is followed by three random speech patterns that called for responses with different pre-prepared nuances ("I would like you to answer this questionnaire", "Please answer the questionnaire", "Answer the questionnaire next to you"). After the utterances are completed, the system checks for passersby in the experimental environment. If no one is detected, the system returns to the initial state 5 s after saying "Hello". If people are continuously detected, the system does not proceed to the next block until an increase or decrease in the number of people is detected. When an increase or decrease in the number of people occurred, the robot returns to the initial state 5 s after saying "Hello" and either repeats the statement or waits in the initial state.

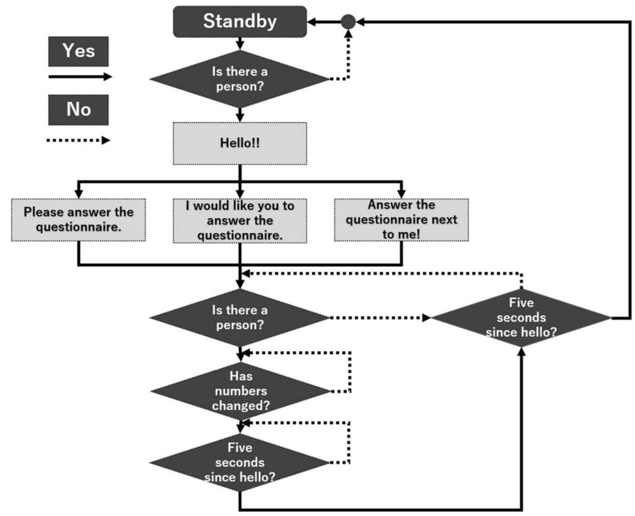


Fig. 4 Flowchart of response. Gray boxes indicate speech, and diamonds indicate branching. The next step is determined based on the recognition results

2.2.6 Measurements

The following three points were measured to evaluate the effectiveness of the robot and audio.

- Number of sheets of valid questionnaires answered
- Number of people who passed through the experimental environment
- Number of words in the free response section of the questionnaire

The questionnaire included nine questions such as "How many times have you visited?" and "Which exhibit did you like the most?" (See Appendix A). If any of the nine questions were answered, the number of valid responses was counted. In contrast, those with blank sheets of paper or scribbles were excluded. The number of people who passed through the environment was measured manually by an outside contractor based on video images to avoid counting the same person passing through the environment. Additionally, infants with difficulty answering the questionnaire were excluded from the study. The number of words written in the free description column was measured to compare the changes in the behavior of the respondents due to the use of the system. Based on this, we defined the response rate and number of words as follows:

S : Number of valid questionnaires answered
P : Number of people who passed through the experimental environment

W : Total number of words in the free response section of the questionnaire

$$\text{Responserate} = \frac{S}{P} \quad (1)$$

$$\text{Numberofwords} = \frac{W}{S} \quad (2)$$

The response rate and number of words were calculated for each day, and the average of the seven-day experimental period for each condition was used as the test statistic and analyzed using the randomization test [28] in a blocked random alternation design. The randomization test reveals how extreme the statistic obtained from the experiment is compared to that calculated for each possible random combination under the hypothesis that the intervention has no effect. This test method is widely used in applied behavior analysis experiments, such as those in this study.

2.2.7 Hypothesis and Predictions

Previous studies reported that using robots increases the amount of information provided to the visual and auditory senses, which leads to trusting [29]. Moreover, the interaction time increases more with robot-assisted guidance than with display guidance [30]. In addition, robot entities can influence behavior through interaction more effectively than guidance using only voice or text [31]. Additionally, physically present robots significantly increase adherence to rules compared to video-displayed agents [32] and elicit more social behavior, which is beneficial for learning compared to virtual agents [33]. Therefore, we formulated the following hypothesis:

H. Installing a robot increases participation in the questionnaire.

If this hypothesis holds, we expect the response rate to increase when using robots compared to audio or no guidance conditions. In addition, the presence of a robot was expected to increase interest in the survey and to answer it attentively. In this regard, we make the following predictions:

- P1-a. The robot condition increases the response rate compared with the none condition.
- P1-b. The robot condition increases the response rate compared with the audio condition.
- P2-a. The robot condition increases the number of words compared with the none condition.
- P2-b. The robot condition increases the number of words compared with the audio condition.

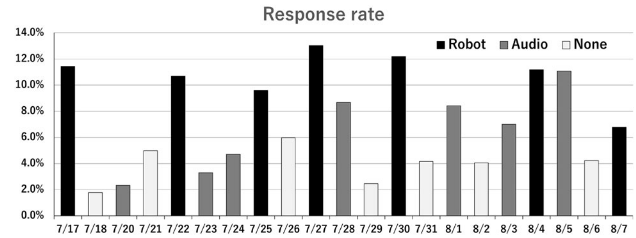


Fig. 5 Daily response rate for each condition in Experiment 1

2.2.8 Ethical Considerations

This study was approved by the Ethical Review Board (2021R476) of the University of Tsukuba.

2.3 Results

2.3.1 Response Rate

Figure 5 shows the response-rate results. The response rate for the robot condition ranged from 6.7% to 13.0% (mean = 10.3%), for the audio condition ranged from 2.3% to 11.0% (mean = 6.0%), and for the none condition ranged from 1.7% to 5.9% (mean = 3.5%).

The results of the randomization test between conditions based on blocks of three days indicated significant differences between the robot and none conditions (p =0.007) and between the robot and audio conditions (p =0.031). No significant differences were observed between the audio and none conditions (p =0.054). The robot response rate for the robot condition is always higher than that for the none condition when compared with blocks of three days. The response rate for the audio condition is higher than that for the none condition in the first half of the experiment. However, in the second half, the results of the audio condition exceeded those of the none condition and are almost equal to those of the robot condition.

2.3.2 Number of Words

Figure 6 presents the results for the number of words. The number of words ranged from 9.1 to 13.2 characters per page in the robot condition (mean = 10.7), from 7.5 to 20.5 characters in the audio condition (mean = 11.8), and from 10.8 to 36.2 characters in the none condition (mean = 21.1). The results of the randomization test indicate significant differences between the robot and none conditions (p =0.015) and between the audio and none conditions (p =0.008). No significant differences are observed between the robot and audio conditions (p =0.344).

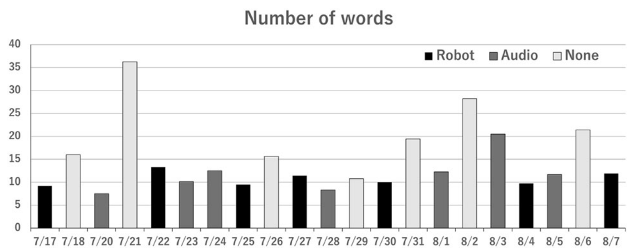


Fig. 6 Daily number of words for each condition in Experiment 1

2.4 Discussion

First, the response rate was significantly higher in the robot condition than in the none condition, confirming that installing the robot had a certain effect on encouraging people to respond to the questionnaire. This result supports Prediction 1-a. Moreover, significant differences were observed between robot and audio conditions. However, Fig. 5 shows an upward trend in the results for the audio condition. This increase might be influenced by effects such as the novelty effect and the ceiling effect [34–36]. The novelty effect suggests that initial improvements may occur due to the newness of the audio intervention, but these effects are likely to diminish over time as participants become accustomed to it [34, 35]. Additionally, the ceiling effect indicates that there is an upper limit to the response rate, beyond which further increases are improbable [36]. Therefore, it is improbable that this upward trend would persist indefinitely over an extended duration of the experiment. To confirm the reproducibility of these findings and to investigate whether this trend continues, we conducted Experiment 2, as detailed in Sect. 3, to retest Prediction 1-b.

Second, the none condition was significantly larger than the robot condition in terms of the number of words, which does not support prediction 2-a. Specifically, although the call alerted the participants to the questionnaire, the effectiveness of the call in terms of increasing the number of words could not be verified. This result suggests that the none condition may have made it easier for the participants to write their opinions and emotional responses. Conversely, in the robot and audio conditions, the average number of words could have decreased as descriptions were not provided. No significant difference was observed between the robot and audio conditions, which did not support Prediction 2-b. The presence or absence of a call influenced the response rate and number of words, but the presence or absence of the robot did not influence the number of words.

Fig. 7 Robot condition in Experiment 2. In the audio condition, the robot is covered with a cloth as in Experiment 1

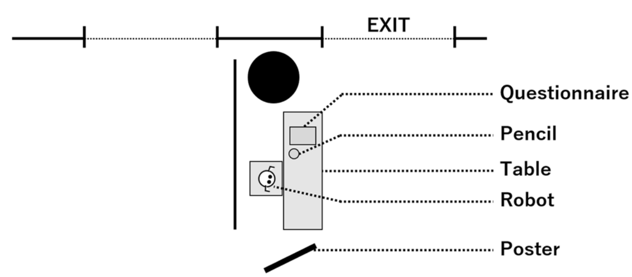


Fig. 8 Diagram of the environment

Table 3 Assignment of the conditions on a schedule

	1	2	3	4	5	6	7	8
Robot	12/11	12/19	12/25	1/9	1/15	1/22	1/30	2/6
Audio	12/12	12/18	12/26	1/8	1/16	1/23	1/29	2/5

3 Experiment 2

3.1 Purpose

The results of Experiment 1 suggest that there were differences between the robot and none conditions. In addition, we observed an upward trend in the results under audio conditions, raising concerns regarding the sustainability and credibility of their effects. It is improbable that this trend would persist indefinitely over an extended duration of the experiment. Therefore, a definitive difference between the robot and audio conditions cannot be ascertained.

To address these concerns and to retest Prediction 1-b, we decided to conduct Experiment 2. The purpose of this follow-up study was to verify the reproducibility and reliability of our findings from Experiment 1. Specifically, the experiment was conducted over 16 days at the same science museum, where we placed a robot and a loudspeaker at the museum exit to reassess the effects of the robot and audio interventions. Since Experiment 1 revealed that the presence of a call to action increased the response rate, the none condition was not included in this experiment.

Thus, Experiment 2 serves as a continuation of our research, building upon the findings of Experiment 1 to confirm their reproducibility and reliability. While there are some differences in the experimental settings due to practical constraints, conducting the study in the same museum allows us to consider the participant populations as similar. Therefore, we believe that Experiment 2 is valid and effective in providing additional insights to support our overall conclusions.

3.2 Experimental Method

3.2.1 Participants

In this experiment, all visitors to the Science Museum were included because they always passed through the experimental environment. Young children who had difficulty answering the questionnaire were excluded from the comparison. (Because the age of visitors was set as 4 years or above, we assumed that infants were excluded.) Consequently, the total number of participants was 8410.

3.2.2 Conditions

Two conditions were set up to clarify the effect of calls with and without the robot (Fig. 7). One condition involved the installation of a robot to call passersby to respond (robot condition), and the other involved the installation of only a speaker to call passersby (audio condition).

3.2.3 Experiment Schedule

To clarify the effect of the two conditions on the number of responses, we used an alternating treatments design similar to that in Experiment 1. The experiment was conducted on Saturdays and Sundays between December and February for 16 days, eight days under each condition (Table 3). During the first six days, the experiment lasted for 430 min, from 9:50 a.m. to 5:00 p.m. For the latter ten days, the closing time was one hour earlier; thus, the experiment lasted 370 min. During the experiment, the two conditions were randomly rearranged weekly based on the alternating treatments design.

3.2.4 Environment

In Experiment 1, the response space was close to the exhibit, which may have caused participants to perceive the questionnaires and calls as part of the exhibit. Therefore, this experiment was conducted in front of the exit and away from the exhibit (Fig. 8).

3.2.5 System

The system used in Experiment 1 was replicated for Experiment 2. However, owing to changes in the experimental environment at the exit of the science museum, the camera position and the robot's speech pattern were altered to fit the new setting. A camera for recognizing passersby was installed behind the robot. The robot's speech, adapted for the exit environment, followed an initial "Hello" and included three text variations enclosed in quotes: "I hope you will answer the questionnaire before leaving", "Answer the questionnaire", and "Please answer the questionnaire. Come again".

3.2.6 Measurements

As in Experiment 1, the following three items were measured.

- Number of sheets of valid questionnaires answered
- Number of people passing through the experimental environment
- Number of words in the free response section of the questionnaire

The response rate and number of words were defined as in Experiment 1.

However, owing to the change in the experimental environment, an additional question was added to the questionnaire, resulting in ten questions.

3.2.7 Hypothesis and Predictions

To test the hypothesis, the predictions that could not be verified in Experiment 1 were tested.

P1-b. The robot condition increased the response rate compared to the audio condition.
P2-b. The robot condition increased the number of words compared to the audio condition.

3.2.8 Ethical Considerations

This study was approved by the Ethical Review Board (2021R476-1) of the University of Tsukuba.

3.3 Results

3.3.1 Response Rate

Figure 9 presents the response rate results. The response rate for the robot condition ranged from 1.9% to 4.5% (mean = 3.2%), whereas that for the audio condition ranged from 0.6% to 3.2% (mean = 1.2%). The results of the randomization test between the conditions based on blocks every alternate day indicated a significant difference between the conditions (p =0.007). The audio condition outperformed the robot condition only once when compared with the blocks every alternate day.

3.3.2 Number of Words

Figure 10 presents the results for the number of words. The results of the robot condition ranged from 5.2 to 11.1 words (mean = 9.3), whereas those of the audio condition ranged from 7.5 to 55.4 words (mean = 17.8). A randomization test based on two-day blocks indicated no significant differences (p =0.242).

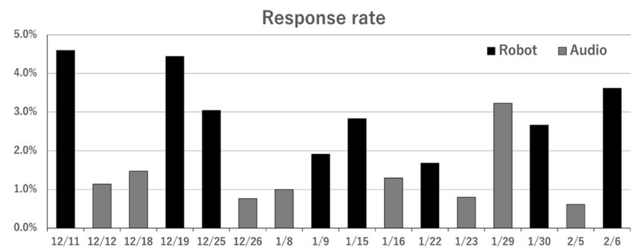


Fig. 9 Daily response rate for each condition in Experiment 1

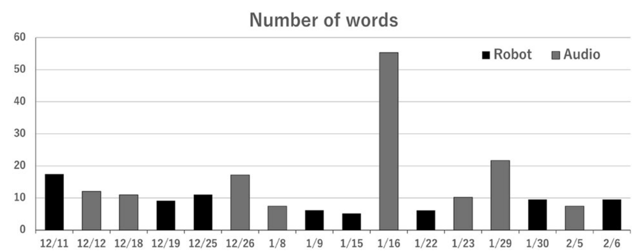


Fig. 10 Daily number of words for each condition in Experiment 2

3.4 Discussion

First, a significant difference existed in the response rate between the robot and audio conditions. Additionally, unlike in Experiment 1, no evidence of an increase in the response rate was observed in the audio condition. This suggests that the installation of the robot has a certain effect on the response rate. This result supports Prediction 1-b. Although there was one day (1/29) during the period when the results of the audio condition exceeded those of the robot condition, it was the day with the lowest number of visitors (217) during the entire experimental period, which is the reason for the trend based on probability.

Second, no significant differences were observed in the number of words between the robot and the audio conditions. As in Experiment 1, the presence or absence of the robot did not affect the number of words. This result did not support Prediction 2-b.

A discussion on Experiments 1 and 2 is presented in the next section.

4 General Discussion

4.1 Verification of Hypothesis

We examined whether the results of these two experiments matched our prior predictions to determine if our hypothesis was supported. The use of physically present robots increased the number of participants who complied with the requests, leading to higher response rates compared with the other two conditions. However, there was no increase in the number of words in the free-response section. Based on these findings, we conclude that our hypothesis is partially supported. The details of the verification of each prediction are described in the following section.

4.1.1 Verification of Prediction 1

The results of our experiments provided evidence to support Prediction 1.

P1-a: The robot condition increased the survey response rate by approximately three times compared to the none condition. This supports Prediction 1-a.

P1-b: Compared with the audio condition, the robot condition increased the questionnaire response rate by approximately 1.7 and 2.5 times in Experiments 1 and 2, respectively. Thus, Prediction 1-b is supported.

First, the results of the robot condition increased the response rate by approximately three times compared with the none condition (Fig. 5). This result was determined to be significant through the randomization test. There are two phases in responding to a questionnaire: awareness of the presence of the questionnaire and responding to it. We believe that using a robot can increase the possibility of noticing the questionnaire visually and orally and may motivate the respondents to respond.

Second, the results of the robot condition increased the response rate by approximately 1.7 times in Experiment 1 (Fig. 5) and 2.5 times in Experiment 2 compared to the audio condition (Fig. 9). This result is significant in the randomization test. In the audio condition, the call may have been drowned by the voices of the building's public announcement and conversation, but we believe that the robot made the questionnaire more visually appealing and recognizable.

Since these two predictions were correct, we confirm that using social robots effectively encourages survey participation. The larger increase in responses observed in Experiment 2 compared to that in Experiment 1 is likely since there were fewer surrounding exhibits in Experiment 2, making the robot more visually prominent.

4.1.2 Verification of Prediction 2

The results of our experiments did not support Prediction 2.

- P2-a: The none condition increased the number of words by approximately two times compared to the robot condition in Experiment 1. Therefore, Prediction 2-a was not supported.
- P2-b: The audio condition increased the number of words by approximately 1.1 and 1.9 times more to the robot condition in Experiments 1 and 2, respectively. Thus, Prediction 2-b was not supported.

First, the results for the robot condition (Fig. 6) confirmed that the none condition increased the number of words by approximately two times compared to the robot condition. This result was significant in the randomization test. Specifically, the results did not support Prediction 2-a, which stated that the robot condition had more words than the none condition.

Second, in the audio condition, the number of words increased by 1.1 and 1.9 times than that in the robot condition in Experiment 1 (Fig. 6) and Experiment 2 (Fig. 10), respectively. However, the results did not differ significantly between the randomization tests. This result does not support Prediction 2-b, which states that the robot condition has more words than the audio condition.

Our predictions, specifically Prediction 2 (which anticipated an increase in the number of words written by participants in the robot condition), were not supported by the results. Two main factors could explain why our predictions were not supported.

Firstly, there was a flaw in our prediction settings. The system's prompt was simply to "please answer the questionnaire," without specifically asking participants to "write more words" or provide detailed responses. Our prediction assumed that the presence of the robot would naturally encourage participants to give longer answers. However, without explicit instructions targeting the length of the response, participants may not have been motivated to write more. This indicates a misalignment between our prediction and the actual experimental manipulation.

Secondly, factors related to participant behavior and the experimental environment may have contributed to the lack of support for our prediction. Providing longer answers would require respondents to spend more time in the experimental environment, potentially compromising the anonymity of the survey. Participants might have been reluctant to write lengthy responses in a public setting due to concerns about privacy or time constraints. Additionally, the system used in this experiment repeatedly prompted participants if other passersby walked behind them or if recognition errors occurred, which might have been perceived as an annoyance, further discouraging longer responses. These are the reasons why our predictions were not supported.

4.2 Analysis of Answers

The number of words varied between conditions because of system installation. Therefore, we determined whether there were differences in the quality of the responses across conditions. Specifically, we analyzed two points: whether there were any differences between conditions in the responses to the multiple-choice questions and whether there were changes or differences in the content of the answers to the freely descriptive questions.

4.2.1 Responses to Multiple-Choice Questions

The number of responses to the eight questions in Experiments 1 and 2 was summed for each condition to calculate the percentage of responses. In Experiment 1, the number of responses to the robot, audio, and none conditions were 94.9, 94.4, and 92.7%, respectively, indicating no differences between the conditions. In Experiment 2, the robot and audio conditions showed no significant differences at 98.2% and 98.4%, respectively. Specifically, the tendency of differences in the percentage of responses generated under different calling conditions could not be confirmed. The reason for the difference between Experiments 1 and 2 may be the difference in experimental environments. The details are discussed in Section 4.4.

4.2.2 Responses to Freely Descriptive Questions

The free-response comments were categorized into two distinct types: "suggestions" related to improvements or changes in the facilities and exhibits, and "emotional responses" expressing visitors' personal feelings about their experience. For instance, a suggestion could be "I wish there were more interactive exhibits", indicating a desire for enhancements. In contrast, an emotional response might be "It was fun! I want to come again", reflecting a positive emotional reaction to their visit. These categories were determined based on the content of the comments: statements requesting changes or offering improvements were classified as "suggestions", while expressions of personal feelings or emotions were classified as "emotional responses". To ensure the classification accuracy, we asked two people unrelated to the experiment to classify 20% of the data. The results indicated that Fleiss' kappa was 0.81, indicating that this classification was properly performed and could be described as Almost Perfect' [37]. This high level of agreement indicates that the agreement among the evaluators is considerably high.

Generally, surveys and free-form responses are more likely to be completed by individuals who have strong opinions, meaning that emotional responses are less likely to be provided. Research has indicated that individuals with strong positive or negative emotions are more inclined to respond to surveys. For example, Anderson reported that consumers who experience extreme satisfaction or dissatisfaction tend to share their experiences with others [38]. Similarly, Dellarocas et al. found that extreme opinions were shared more frequently in online environments [39].

However, in our study, the proportion of emotional responses among the total number of descriptive responses increased in the robot and audio conditions. Specifically, in the none condition, 74% of the descriptive responses were classified as "emotional responses", whereas introducing robots and voice systems increased the emotional responses to 86%. This suggests that even individuals who do not hold strong opinions and might not typically participate were more inclined to respond when technological interventions (robots and audio) were present. This leads to the collection of more diverse feedback.

4.3 Potential of Using Robots in Questionnaire Task

Although we did not directly compare the effectiveness of human and robot facilitators in our study, the role of robots in the questionnaire tasks warrants attention, particularly in the context of experimenter effects. As highlighted in previous research, this phenomenon indicates that human involvement in surveys can inadvertently lead to biased responses owing to the psychological pressure exerted on participants [40, 41]. Robots offer a more neutral presence, potentially minimizing this bias and improving the authenticity of the collected feedback.

Building on this foundation, the theoretical implications of using robots in survey contexts are consistent with the challenges identified in previous studies [42, 43]. By providing a level of anonymity and reducing psychological burden, robots can play a crucial role in ensuring genuine and reliable responses in questionnaire-based research. Although our current study does not provide empirical evidence for this hypothesis, it presents an intriguing direction for future research exploring the potential of robots as impartial facilitators during data collection.

4.4 Influence of the Experimental Environment

This section discusses the effects of the experimental environment.

First, we discuss the differences between environments used in other studies. We found two studies conducted in a shopping mall that measured the number of people who changed their behavior in a real environment for all the people passing by, similar to this study. Nearly 3.6% of passersby in both studies interacted with robots when called [1, 2]. In contrast, in our study, 10.3% of participants in Experiment 1 and 3.2% of participants in Experiment 2 responded (interacted). The previous two studies provided benefits to participants. In contrast, in our study, participants did not benefit from answering the questionnaire. The results of Experiment 2 were almost equal to those of the previous work, and the results of Experiment 1, in which the exhibits were nearby, were higher than those of the previous work.

Despite the non-beneficial interactions, the reason for these results is that the experiments in this study were conducted at a science museum. As the experimental period was during summer vacations and holidays, children made up a large proportion of the participants. A previous study [44, 45] showed that children are more prone to excessive engagement with robots than adults, which may have had an impact. It has also been demonstrated that negative feelings and anxiety toward robots can affect interactions [46, 47]. Since the experiment was conducted in a science museum, it was characterized by the fact that many of the participants had positive feelings toward the robot.

Next, we compare the results of Experiments 1 and 2. We observed that the response rate decreased considerably in Experiment 2 compared with Experiment 1, possibly due to the location of the experiment. Because Experiment 1 was conducted in a corridor in front of the exhibition hall but inside a science museum, the robot may have been perceived as part of the exhibit. However, Experiment 2 was conducted outside the Science Museum exit. It is believed that many visitors noticed the system when they were about to head home after viewing the museum exhibits. Therefore, the questionnaire was perceived as a formal questionnaire rather than part of the exhibition, which may have raised hurdles in answering the questionnaire. Therefore, to increase the number of questionnaires collected, it would be more effective to place the questionnaire in a position where participants would perceive it as part of the exhibition. It was also suggested that the response rate tended to be higher in the robot condition than in the audio condition when the experimental environments differed.

4.5 Effectiveness of Real Robots

In our study, the physical presence of the robot moving in sync with the voice call was observed to substantially influence participant behavior. The experimenters noticed that participants often paused to mimic the robot's movements, suggesting enhanced engagement and understanding of the questionnaire's location and call target. This observation underlines the importance of a robot's physical presence in aiding comprehension and interaction. Consistent with previous research that emphasized the significance of the accompanying motion with speech in various contexts [27], our findings demonstrate that this is particularly relevant in the context of robots.

The addition of movement to the robot's physical presence played a pivotal role in our study. Although the mere presence of a static entity, such as a robot without motion, could have some impact, the integration of movements markedly enhanced participant engagement and comprehension. This aligns with the findings of Chidambaram et al., who showed that the integration of movement with speech in robots have a greater impact than speech alone [48]. If the robot remained stationary, its ability to attract attention and convey information would be considerably reduced. During the audio condition, there were instances where passersby, upon hearing the audio call, approached staff members with questions such as, "Where is this questionnaire?" This phenomenon emphasizes the added value of movement in effectively guiding individuals towards the intended target-in this case, the questionnaire. Thus, the combination of a physical robot with synchronized movement towards the sound source emerges as a crucial factor in improving the effectiveness of the communication and interaction process, which supports the findings of Powers et al. that physical robots enhance reliability and prolong the interaction time compared to nonphysical display agents [30].

Moreover, a comparison between the audio and none conditions revealed that the incorporation of only voice yielded discernible effects. These findings suggest that augmenting the response rates to questionnaires solely through voice guidance is feasible. The insights gained from this study may facilitate the prudent integration of voice-only calling when needed, especially in scenarios where deploying a robot is impracticable.

4.6 Future Work

An experiment was conducted at a science museum to measure the effectiveness of the robot. Consequently, many passersby in the experimental environment are children or people interested in science. Thus, their interest in robots could have influenced their responses. As mentioned above, the results may differ when similar experiments are conducted at locations with different ages and interests.

The robot movements used in this study were monotonous calls that were prepared in advance. Variations in robot movement are expected to yield better results. Therefore, it is necessary to evaluate the combination of effective calls and movements identified in previous studies. Furthermore, we believe that a comparison between an actual robot and display agent in a calling scene should be considered in the future.

In addition, the system used in this study only repeated pre-prepared speeches, and only the timing of the start of the dialogue was controlled. Therefore, during the experiment, some participants attempted to interact with the robot. However, as soon as they noticed that the same utterances were repeated, they left the robot and did not listen to the call to respond to the questionnaire. A previous study [49] also indicated that participants may stop interacting with a robot system when their behavior differs from what they expect. Therefore, we believe that not only one-sided calls, but also speech adapted to the interaction partner could reduce the number of people leaving during the call, further increasing the response rate. For example, we believe that these problems can be solved using image recognition technology [50], using the personal belongings and clothing of the dialogue partner as part of the call, or using a large-scale language model [51] to enable simple dialogue after the call.

5 Conclusion

In this study, we investigated the effectiveness of using a robot to facilitate responses to a passerby questionnaire compared with audio-only or no calling. Through two field experiments conducted at a science museum, we observed that the response rate was highest when a robot was used, although there was a tendency for more emotional responses to be expressed. Although these findings can serve as essential decision indicators for robot implementation, we recognize that only monotonous calls were used in this study. Future work should aim for both one-way and interactive calling, and a comparison with display agents should be considered. Overall, our results offer promising evidence for the future introduction of robots in various situations, laying the groundwork for more nuanced human–robot interactions and providing an initial quantitative demonstration of their potential effectiveness.

Acknowledgements We thank the TSUKUBA EXPO CENTER staff for their assistance.

Funding Open Access funding provided by Osaka University. This research was funded by JSPS KAKENHI(grant Numbers 22H03895 and 19H05691).

Declarations

Conflict of interest The authors declare that they have no Conflict of interest.

References

1. Okafuji Y, Ozaki Y, Baba J, Nakanishi J, Ogawa K, Yoshikawa Y, Ishiguro H (2022) Behavioral assessment of a humanoid robot when attracting pedestrians in a mall. Int J Soc Robot 14(7):1731–1747
2. Shiomi M, Shinozawa K, Nakagawa Y, Miyashita T, Sakamoto T, Terakubo T, Ishiguro H, Hagita N (2013) Recommendation effects of a social robot for advertisement-use context in a shopping mall. Int J Soc Robot 5(2):251–262
3. Heikkilä P, Lammi H, Niemelä M, Belhassein K, Sarthou G, Tammela A, Clodic A, Alami R (2019) Should a robot guide like a human? a qualitative four-phase study of a shopping mall robot. In: International conference on social robotics. Springer, pp 548–557
4. Niemelä M, Heikkilä P, Lammi H, Oksman V (2019) A social robot in a shopping mall: studies on acceptance and stakeholder expectations. In: Social robots: Technological, societal and ethical aspects of human-robot interaction. Springer, pp 119–144
5. Shiomi M, Kanda T, Ishiguro H, Hagita N (2006) Interactive humanoid robots for a science museum. In: Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction, pp 305–312
6. Vogt P, van den Berghe R, de Haas M, Hoffman L, Kanero J, Mamus E, Montanier J-M, Oranç C, Oudgenoeg-Paz O, García DH et al (2019) Second language tutoring using social robots: a large-scale study. In: 2019 14th ACM/IEEE international conference on human-robot interaction (HRI). IEEE, pp 497–505
7. Kanda T, Sato R, Saiwaki N, Ishiguro H (2007) A two-month field trial in an elementary school for long-term human-robot interaction. IEEE Trans Rob 23(5):962–971
8. Gordon G, Spaulding S, Westlund JK, Lee JJ, Plummer L, Martinez M, Das M, Breazeal C (2016) Affective personalization of a social robot tutor for children's second language skills. In: Proceedings of the AAAI conference on artificial intelligence, 30(1)
9. Kidd Cory D, Breazeal C (2008) Robots at home: understanding long-term human-robot interaction. In: 2008 IEEE/RSJ international conference on intelligent robots and systems. IEEE, pp 3230–3235
10. Jeong S, Logan DE, Goodwin MS, Graca S, O'Connell B, Goodenough H, Anderson L, Stenquist N, Fitzpatrick K, Zisook M et al (2015) A social robot to mitigate stress, anxiety, and pain in hospital pediatric care. In: Proceedings of the tenth annual ACM/IEEE international conference on human-robot interaction extended abstracts, pp 103–104
11. Hebesberger D, Koertner T, Gisinger C, Pripfl J (2017) A long-term autonomous robot at a care hospital: A mixed methods study on social acceptance and experiences of staff and older adults. Int J Soc Robot 9(3):417–429
12. Pinillos R, Marcos S, Feliz R, Zalama E, Gómez-García-Bermejo J (2016) Long-term assessment of a service robot in a hotel environment. Robot Auton Syst 79:40–57
13. Gockley R, Bruce A, Forlizzi J, Michalowski M, Mundell A, Rosenthal S, Sellner B, Simmons R, Snipes K, Schultz AC et al (2005) Designing robots for long-term social interaction. In: 2005 IEEE/RSJ international conference on intelligent robots and systems. IEEE, pp 1338–1343
14. Patrick G, Raftery Adrian E, Hana Š, Li Nan G, Danan ST, Leontine A, Fosdick Bailey K, Jennifer C, Nevena L et al (2014) World population stabilization unlikely this century. Science 346(6206):234–237
15. Dawes M, Summerskill W, Glasziou P, Cartabellotta A, Martin J, Hopayian K, Porzsolt F, Burls A, Osborne J (2005) Sicily statement on evidence-based practice. BMC Med Educ 5(1):1–7
16. Rousseau DM, Gunia BC (2016) Evidence-based practice: The psychology of ebp implementation. Annu Rev Psychol 67(1):667–692
17. Evidence-Based Medicine Working Group et al (1992) Evidence-based medicine, a new approach to teaching the practice of medicine. Jama 268:2420
18. Sanderson I (2002) Evaluation, policy learning and evidence-based policy making. Public Administr 80(1):1–22
19. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, Webb P, Lartey A, Black RE, The Lancet Nutrition Interventions Review Group, et al (2013) Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet 382(9890):452–477
20. Hill N, Brierley J, MacDougall R (2017) How to measure customer satisfaction. Routledge
21. Velentza A-M, Heinke D, Wyatt J (2020) Museum robot guides or conventional audio guides? an experimental study. Adv Robot 34(24):1571–1580
22. Barlow DH, Hayes SC (1979) Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. J Appl Behav Anal 12(2):199–210
23. Sigurdsson V, Engilbertsson H, Foxall G (2010) The effects of a point-of-purchase display on relative sales: An in-store experimental evaluation. J Organ Behav Manag 30(3):222–233
24. Manolov R (2019) A simulation study on two analytical techniques for alternating treatments designs. Behav Modif 43(4):544–563
25. IES WWC What Works Clearinghouse. https://ies.ed.gov/ncee/wwc/handbooks
26. Redmon J, Divvala S, Girshick R, Farhadi A (2016) You only look once: Unified, real-time object detection. In: Proceedings of the IEEE conference on computer vision and pattern recognition, pp 779–788
27. Salem M, Kopp S, Wachsmuth I, Rohlfing K, Joublin F (2012) Generation and evaluation of communicative robot gesture. Int J Soc Robot 4(2):201–217
28. Edgington ES (1980) Validity of randomization tests for one-subject experiments. J Educ Stat 5(3):235–251
29. Kidd CD, Breazeal C (2004) Effect of a robot on user perceptions. In: 2004 IEEE/RSJ international conference on intelligent robots and systems (IROS)(IEEE Cat. No. 04CH37566), vol 4. IEEE, pp 3559–3564
30. Powers A, Kiesler S, Fussell S, Torrey C (2007) Comparing a computer agent with a humanoid robot. In: Proceedings of the ACM/IEEE international conference on Human-robot interaction, pp 145–152
31. Brengman M, De Gauquier L, Willems K, Vanderborght B (2021) From stopping to shopping: An observational study comparing a

humanoid service robot with a tablet service kiosk to attract and convert shoppers. J Bus Res 134:263–274
32. Bainbridge WA, Hart JW, Kim ES, Scassellati B (2011) The benefits of interactions with physically present robots over video-displayed agents. Int J Soc Robot 3:41–52
33. Kennedy J, Baxter P, Senft E, Belpaeme T (2015) Higher nonverbal immediacy leads to greater learning gains in child-robot tutoring interactions. In: Social Robotics: 7th International Conference, ICSR 2015, Paris, France, October 26-30, 2015, Proceedings 7. Springer, pp 327–336
34. Abendschein B, Edwards A, Edwards C (2022) Novelty experience in prolonged interaction: A qualitative study of socially-isolated college students' in-home use of a robot companion animal. Front Robot AI 9:733078
35. Smedegaard CV (2019) Reframing the role of novelty within social hri: from noise to information. In: 2019 14th acm/ieee international conference on human-robot interaction (hri). IEEE, pp 411–420
36. Ligthart MEU, Neerincx MA, Hindriks KV (2022) Memory-based personalization for fostering a long-term child-robot relationship. In: 2022 17th ACM/IEEE international conference on human-robot interaction (HRI). IEEE, pp 80–89
37. Landis JR, Koch GG (1977) The measurement of observer agreement for categorical data. Biometrics 159–174
38. Anderson EW (1998) Customer satisfaction and word of mouth. J Serv Res 1(1):5–17
39. Dellarocas C, Narayan R (2006) A statistical measure of a population's propensity to engage in post-purchase online word-of-mouth. Stat Sci 21(2):277–285
40. Ng CJ (2006) Designing a questionnaire. Malays Fam Phys Off J Acad Family Phys Malaysia 1(1):32
41. Fowler J, Floyd J, Mangione TW (1990) Standardized survey interviewing: minimizing interviewer-related error, vol 18. Sage
42. Ong AD, Weiss DJ (2000) The impact of anonymity on responses to sensitive questions 1. J Appl Soc Psychol 30(8):1691–1708
43. Kahn RL (1952) A comparison of two methods of collecting data for social research: the fixed-alternative questionnaire and the open-ended interview. PhD thesis, University of Michigan Ann Arbor
44. Aaltonen I, Arvola A, Heikkilä P, Lammi H (2017) Hello pepper, may i tickle you? children's and adults' responses to an entertainment robot at a shopping mall. In: Proceedings of the Companion of the 2017 ACM/IEEE international conference on human-robot interaction, pp 53–54
45. Vollmer A-L, Read R, Trippas D, Belpaeme T (2018) Children conform, adults resist: a robot group induced peer pressure on normative social conformity. Sci Robot 3(21):eaat7111
46. Nomura T, Kanda T, Suzuki T (2006) Experimental investigation into influence of negative attitudes toward robots on human-robot interaction. Ai Soc 20(2):138–150
47. Takayama L, Pantofaru C (2009) Influences on proxemic behaviors in human-robot interaction. In: 2009 IEEE/RSJ international conference on intelligent robots and systems. IEEE, pp 5495–5502
48. Chidambaram V, Chiang Y-H, Mutlu B (2012) Designing persuasive robots: how robots might persuade people using vocal and nonverbal cues. In: Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction, pp 293–300
49. Satake S, Kanda T, Glas DF, Imai M, Ishiguro H, Hagita N (2009) How to approach humans? strategies for social robots to initiate interaction. In: Proceedings of the 4th ACM/IEEE international conference on Human robot interaction, pp 109–116
50. Yang M, Yu K (2011) Real-time clothing recognition in surveillance videos. In: 2011 18th IEEE international conference on image processing. IEEE, pp 2937–2940
51. Brown T, Mann B, Ryder N, Subbiah M, Kaplan JD, Dhariwal P, Neelakantan A, Shyam P, Sastry G, Askell A et al (2020) Language models are few-shot learners. Adv Neural Inf Process Syst 33:1877–1901

Taiga Natori received the Master degree in engineering from Tsukuba University, Japan, in 2023. He is currently enrolled in the doctoral program in the Graduate School of Engineering Science at Osaka University. His research interests include human-robot interaction and multiple robots coodination.

Takamasa Iio received a Ph.D. degree from Doshisha University, Kyoto, Japan, in 2012. Then, he has worked at Intelligent Robotics and Communication Laboratories, ATR, Osaka University, and the University of Tsukuba. Currently, he is an associate professor at Doshisha University, Kyoto, Japan. His field of expertise is social robotics. He is interested in how people's cognition and behavior change through interaction with social robots and how human society changes.

Yuichiro Yoshikawa (Member, IEEE) received the Ph.D. degree in engineering from Osaka University, Suita, Japan, in 2005. From 2005, he was a Researcher with Intelligent Robotics and Communication Laboratories, Advanced Telecommunications Research Institute International. Since 2010, he has been an Associate Professor with the Graduate School of Engineering Science, Osaka University. He is a Member of Japanese Society of Robotics, Japanese Society of Cognitive Science, the Virtual Reality Society of Japan, Japanese Society for Child and Adolescent Psychiatry, and Japanese Society of Pediatric Psychiatry and Neurology.

Hiroshi Ishiguro received a D.Eng. in systems engineering from Osaka University, Japan in 1991. He is currently Professor of Department of Systems Innovation in the Graduate School of Engineering Science at Osaka University (2009-), Distinguished Professor of Osaka University (2013-) and visiting Director (2014-) of Hiroshi Ishiguro Laboratories at the Advanced Telecommunications Research Institute and an ATR fellow. His research interests include distributed sensor systems, interactive robotics, and android science. He has published more than 300 papers in major journals and conferences, such as Robotics Research and IEEE PAMI. On the other hand, he has developed many humanoids and androids, called Robovie, Repliee, Geminoid, Telenoid, and Elfoid. These robots have been reported many times by major media, such as Discovery channel, NHK, and BBC. He has also received the best humanoid award four times in RoboCup. In 2011, he won the Osaka Cultural Award presented by the Osaka Prefectural Government and the Osaka City Government for his great contribution to the advancement of culture in Osaka. In 2015, he received the Prize for Science and Technology (Research Category) by the Minister of Education, Culture, Sports, Science and Technology (Mext). He was also awarded the Sheikh Mohammed Bin Rashid Al Maktoum Knowledge Award in Dubai in 2015. Tateisi Award in 2020.