

# Leaving a message with the PaPeRo robot: The effect of interaction experience with real or virtual PaPeRo on impression evaluation

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**Abstract.** This paper describes a simple psychological experiment to investigate the effects of two aspects of user interactions with message taking artifacts. The first is the effect of the artifacts' physical appearance, and the other is prior interaction experience. We examined the effect of these two factors on the ability of users to feel comfortable and natural when interacting with the artifacts. Experimental results revealed that prior interaction experience was a much more important factor than the artifacts' appearance in determining whether participants could leave verbal messages smoothly.

## 1 Introduction

Recently various researchers have been working on achieving intimate relationships between humans and artifacts (e.g., partner robots, life-like agents or game characters) in various research fields, such as human-computer interaction (HCI) and Entertainment Computing (EC). In these situations, if users are uncomfortable interacting with an artifact and feel the interactions are unnatural they definitely cannot achieve an intimate relationship with it. Therefore, one can say that in the studies mentioned above have a common issue, and that is how to make users feel comfortable during these interactions, and to make them feel such interactions are natural.

In a related study, Harada [2] conducted a psychological experiment to investigate whether participants feel comfortable and natural when leaving verbal messages using the following three artifacts: window-based software appearing on a computer display, a character agent appearing on a computer display, and a child care robot (PaPeRo robot developed by NEC corporation, left in Fig. 1 [3]). In this experiment, participants were asked to leave verbal message about a memo by using those artifacts as if they were leaving messages on an answering machine. Harada's results revealed that participants felt comfortable when they passed messages to the robot and felt the interaction was natural, but they did not feel this way toward the software and the agent. Harada then concluded that an artifacts' appearance whether it had physical existence would be an important cue for making users feel comfortable with the artifacts and making them feel that the interaction was natural.

However, before participants used this robot to leave messages, they had verbal conversations with it, as it was equipped with systems for highly accurate speech recognition and fluent speech expression. Actually, Harada intended that this verbal conversation was an orientation phase for participants to learn and understand the functions and behaviors of this robot. However, they did not experience any interactions or conversations with the window-based software or the agent before leaving messages with these artifacts. Therefore, the question was still open as to whether an artifact's physical appearance is the more important cue that causes users to feel comfortable and natural using it, or whether prior interaction and/or conversation experience with the artifacts is more important.

The purpose of this paper is to investigate the effects of these two aspects of artifacts on users' interactions with them: the artifact's appearance whether it has physical existence, and prior experience interacting with artifacts. We examined the effect of these two factors on whether users feel comfortable and natural in these interactions. Specifically, we conducted a simple psychological experiment in which participants leave verbal messages with the PaPeRo robot or with a PaPeRo's character animation created with computer graphics on a PC screen (PaPeRo CG) in two different situations. In one instance, they experience verbal conversations with the PaPeRo before leaving messages, and in the other they do not. The results of this study will contribute to creating effective interactive artifacts, such as partner robots or video game characters, that can induce natural user behaviors, and it will contribute to finding the trigger that induces intimate interactions between users and artifacts.

## 2 Experiment

### 2.1 Participants

The participants were 40 Japanese university students (36 men and 4 women; 18-22 years old). They did not have any previous experience interacting with PaPeRo or of observing its behaviors. These 40 participants were randomly assigned into the four groups, and participants in each group were asked to leave verbal messages by using the following objects under the following conditions:

- **Group 1:** PaPeRo robot with having interaction experience prior to leaving messages.
- **Group 2:** PaPeRo robot without advance interaction experience.
- **Group 3:** PaPeRo CG with advance interaction experience.
- **Group 4:** PaPeRo CG without advance interaction experience.

### 2.2 Objects used for leaving verbal messages

Participants used two objective artifacts to leave messages. There were the PaPeRo robot (left in Fig. 1), and PaPeRo animation depicted by computer graphics as PaPeRo CG (center in Figure 1).

The PaPeRo robot is 385 mm tall, 248 mm wide, and 245 mm thick. The PaPeRo CG appeared on a 17-inch display so that its actual size was about 200 mm x 150 mm x 150 mm. Participants in Groups 1 and 2 were asked to leave messages with the

PaPeRo robot, while participants in Groups 3 and 4 did so with the PaPeRo CG. Both the PaPeRo robot and PaPeRo CG were activated by the same robot controller and sound recognition and expression system. Therefore, both can express the same behaviors and the same speech sounds, so there are no apparent differences in their functions. In other words, the differences between these two are just whether PaPeRo exists in the physical world or the virtual world.”

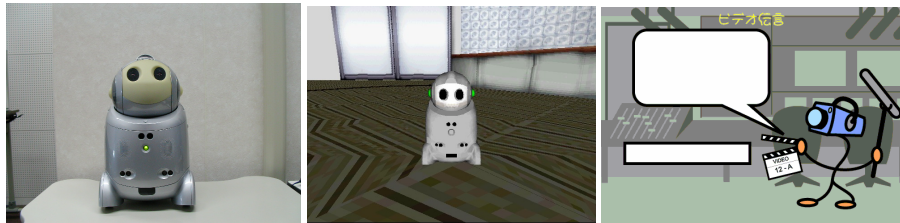


Fig. 1. PaPeRo robot (left), PaPeRo CG (center) and character agent (right)

### 2.3 Interaction experiences

Participants in Group 1 and 3 were assigned to leave messages after having prior interaction experience, while participants in groups 2 and 4 were to do so without experiencing interactions before leaving messages. These two conditions were designed as the follows:

- (Group 1 and 3) Those participants who had interaction experience in advance were passed a memo that listed 10 simple words that PaPeRo could recognize, and respond to with comical actions, e.g., if participants selected the word hello and addressed PaPeRo, the robot responded by saying “bonjour!” and dancing. Before leaving messages, these participants were asked to use five words from this list. The total time of this interaction was within two minutes at maximum.
- (Group 2 and 4) The other participants did not have any advance interaction with PaPeRo robot or PaPeRo CG.

### 2.4 Procedure

The experimental procedure was the nearly same as in Harada’s study mentioned above in the introduction of this report.

1. All 40 participants were asked to leave verbal messages with the character agent appearing on a computer display as a preliminary session (right in Fig. 1). Specifically, participants were passed a message memo, e.g., “To Mr. Suzuki. English Exam. 4 PM. Lecture Hall B.” and asked to leave a verbal message about this memo with this agent as if leaving a message on an answering machine.
2. Afterward, participants were asked to answer questions about this character agent; the questions are Part 1 of the questionnaire that is presented in Fig. 2.
3. The participants were then asked to leave messages with the PaPeRo robot or PaPeRo CG according to the corresponding conditions described

above as the main session. In this session, the participants were passed a message memo different from that used in the preliminary session.

4. Afterward, all participants were asked to answer questions about PaPeRo that are in Parts 1 and 2 of the questionnaire. In addition, the participants in Groups 1 and 3 who had prior interaction experience before leaving messages were asked to also fill in Part 3 of the questionnaire.

The three kinds of questionnaires mentioned above and shown in Fig. 2 were designed as a six-point likert scale (the lower the points, the poorer the assessment: zero was the worst assessment, and five points was the best).

Part 1. About the object used for leaving message	Part 2. About your impression of PaPeRo	Part 3. About interaction experiences
Q1. Could you successfully leave messages?	Q7. Did you think PaPeRo was cute?	Q11. Could PaPeRo and you communicate smoothly?
Q2. Did you feel that the object was staring at you?	Q8. Did you think PaPeRo was sociable?	Q12. Did you enjoy the conversation with PaPeRo?
Q3. Did you feel embarrassed when you left messages?	Q9. Did you feel establish rapports with PaPeRo?	Q13. Did you want to experience these kinds of conversations?
Q4. Did you enjoy leaving messages with this object?	Q10. Did you think PaPeRo was reliable?	
Q5. Could you leave messages without being at a loss for words?		
Q6. Did you want to use this way of leaving message again?		

Fig. 2. Questionnaire used in this experiment

## 2.5 Results

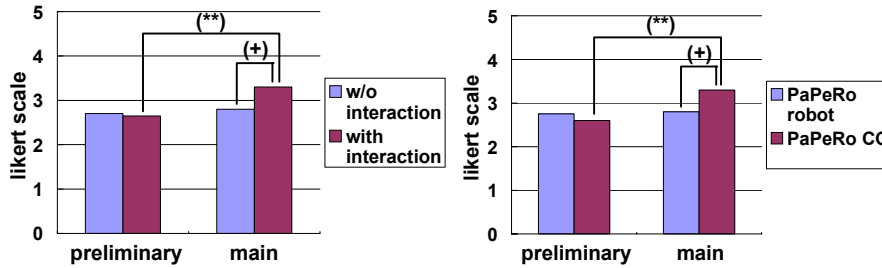


Fig. 3. Relationship between prior interaction experience and session factors (left) and that between physical appearance and session factors (right) for Q6.

**Questionnaire Part 1: About the object used for leaving messages.** Each of the six questions in Part 1 was analyzed with a 2 (physical appearance: robot or CG) x 2 (interactions: with or without prior experience) x 2 (sessions: preliminary or main) mixed ANOVA. The results of the ANOVA revealed that there were significant differences in the answers to Q4, Q5, and Q6.

For Q4, “*Did you enjoy leaving messages with this object?*” a significant tendency in the second-order interaction ( $F(1, 36) = 3.75, p < .075 (+)$ ) was revealed, and a sig-

nificant difference in the main effects of a session factor ( $F(1,36)=66.15, p<.01(**)$ ) was found. In sum, we can say that the participants enjoyed leaving message with the PaPeRo regardless of the two kinds of physical appearance.

For Q5, “*Could leave messages without being at a loss for words?*” significant differences in main effects were found for session factor ( $F(1,36)= 7.62, p<.01(**)$ ). In sum, we can say that the participants could leave messages with the PaPeRo without being at a loss for words regardless of the two types of physical appearance.

For Q6, “*Did you want to use this way of leaving messages again?*” we found significant tendency in the interaction between prior interaction experience and session factors ( $F(1,36)=3.88, p<.075(+)$ ), and a significant difference in the interaction between physical appearance and session factors ( $F(1,36)=5.41, p<.05(*)$ ). In sum, we can say that participants who experienced prior interactions and conversations with the PaPeRo robot wanted to use it again as a way of leaving messages (Fig. 3).

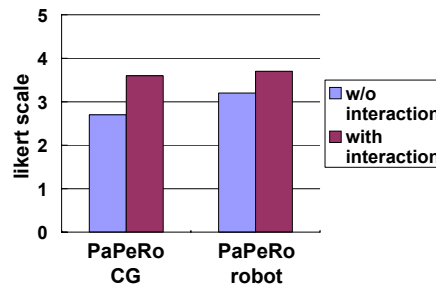


Fig. 4. Relationship between physical appearance and interaction experiment factors for Q8.

**Part 2: About your impression of PaPeRo.** Each of the four questions in Part 2 was analyzed with a 2 (physical appearance: robot or CG) x 2 (interactions: with prior experience or without) ANOVA. The results of the ANOVA determined that there were significant differences answers to Q7, Q8, and Q9.

For Q7, “*Did you think PaPeRo was cute?*” a significant difference in the interaction between two factors ( $F(1,36)=4.64, p<.01(**)$ ) was found. Therefore, we can say that particularly the participants who had prior interaction experiences thought that the PaPeRo robot was cute.

For Q8, “*Did you think PaPeRo was sociable?*” a significant tendency was found in the main effects of interaction experience factors ( $F(1,36)=3.90, p<.075(+)$ ). Then, we can say that the participants who had prior interaction experiences thought that the PaPeRo was sociable regardless of the two types of physical appearance (Fig. 4).

For Q9, “*Did you feel establish rapport with PaPeRo?*” we found a significant tendency in the main effects of the interaction experience factor ( $F(1,36)=8.73, p<.01(**)$ ). Thus, we can say that the participants who had prior interaction experiences felt rapport with the PaPeRo regardless of the two types of physical appearance.

**Part 3: About the interaction experiences.** The each of three questions in Part 3 answered by participants in Group 1 and 3 was analyzed by a 2 (interactions: with or without prior experience) ANOVA. This ANOVA result determined that there was no significant difference was found.

### 3 Discussion and Conclusions

From the results of the experiments, the following phenomena were confirmed.

- When participants left verbal messages with the **PaPeRo robot after having prior interaction experience**, they answered that they wanted to use the robot again, and that it was cute.
- They established rapport with the **PaPeRo regardless of the type of physical appearance presented if they had prior interaction experience**, and they felt that it was sociable and familiar.
- There were no significant differences in Part 3 of the questionnaire for Groups 1 and Group 3, both of whom had prior interaction experiences with the PePeRo, regardless of the type of physical appearance.

To summarize this result, we can say that prior interaction experience with the artifacts was a much more important cue for participants to be able to leave verbal messages smoothly. In other words, a prior interaction (only a few minutes) made participants feel that interaction with the artifacts was comfortable and natural. This result could contribute to advancement of HCI and EC applications, such as immersive video game characters or interactive virtual assistants appearing on a computer display or a PDA. Moreover, this result should have some impact on research in HCI and EC in that most researchers have previously believed that interactive artifacts must have physical existence and exist in the same physical world as humans [1].

However, this result also confirmed an advantage in the artifacts' having physical existence in that participants' impressions about them; that is, physical existence of artifacts might affect the emotional aspects of interactions, such as "I want to use this robot again (Q6)," or "this robot is cute (Q7)." Moreover, Q4 and Q5 revealed that the PaPeRo regardless of the type of physical appearance received a higher evaluation compared to the character agent appearing on a computer display. This means that the design of artifacts might also have some effects on whether users feel comfortable and natural when using them.

Therefore, to develop the artifacts required that induce natural user behaviors, two requirements are providing interaction experience for users, and designing an appropriate appearance for artifacts according to their use.

### References

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