The Effects of a Robot's Poses on User Perception and Self-Projection

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***Abstract*—In order to explore the use of companion robots in people's everyday lives, we were inspired by "Nuikatsu," a popular social trend in which people bring their stuffed toys with them while engaging in various everyday activities, and conducted a study to let participants use a robot instead of stuffed toys for Nuikatsu-like activities. This time, our focus is the robot's pose, and we studied whether or not the robot's pose is customized by the user influence the user's degree of self-projection, as well as perceptions of anthropomorphism, animacy and likeability, in both indoor and outdoor environments. Our study revealed that in both indoor and outdoor settings, a robot with a customized pose did gave our participants a stronger feeling of self projection, as well as a stronger perception of anthropomorphism, animacy and likeability.**

***Index Terms*—companion robots, human–robot interaction, pose customization, self-projection, anthropomorphism, Nuikatsu**

I. Introduction

"Nuikatsu" is a combination of the Japanese saying "Nuigurumi"(stuffed toys) and "Katsudo"(activity). In practice, people carry their stuffed toys with them and engage in everyday activities, while taking photos of them and uploading onto social networking platforms [1], [2].

Why do people do Nuikatsu? Ogawa [1] mentioned two possibilities. One considered stuffed toy as a form of self-projection, acting as a representation of the owners themselves. In Nuikatsu, the idea of customization has been widely applied, as owners use unique clothes and accessories to decorate their stuffed toys, making them more distinct from their original states. The other possibility referred stuffed toys as companions that "go with" instead of being "carried by" their owners. It is also noted that stuffed toys are considered as "silent" friends, maintaining a quiet, slow-paced, and reassuring relationship without worrying about owners' opinions being criticized.

Besides in Nuikatsu, the use of stuffed toys as companions has also been studied. Both being non-human companions, when compared with animal-assisted activities in which pets are used, stuffed animal-assisted activities have the advantages of spending no cost on raising the animals, as well as less worries of injury [1], [3]. Actually, using robots as companions, or robot-assisted activity (or therapy) [3], [4], can also share such advantages. Furthermore, robot-assisted activity can even do better in psychological stress relief effects when compared to stuffed animal-assisted activity [3]. We have also seen the application of the famous seal robot Paro [5] in various scenes from homes to special care facilities, as a companion to help users fight against anxiety, encourage communication and support rehabilitation.

The idea of "self-projection" in Nuikatsu has also been a research interest in HRI, especially in Robot Telepresence(RT). In Houda et al.'s study [6], students who used telepresence robots to attend classes remotely were encouraged to customize their robots to strengthen their presence, letting the tele-operated robots better represent themselves. Similarly, self-extension, a term specifically used in robot teleoperation has also been a HRI research interest, in which the tele-operated robot is seen as a extension of the tele-operator [7]. According to Groom [7], the importance of understanding self-extension lies in the decision of when to maximize or minimize self-extension.

Nuikatsu is an activity that include scenes both indoors and outdoors, with relatively artificial environments(e.g. cafes) and natural environments(e.g. parks), and this triggered our curiosity about what role does environment play in Nuikatsu. In previous studies, natural environments can help in faster and more complete recuperation of stress when compared to urban environments [8]. Moreover, natural environment has been proved to help in the restoration of attention [9].

In this study, we explore the possibility of using the robot Sota as a substitute for stuffed toys in Nuikatsu-like activities, aiming to understand how companion robots can fit more naturally into people's everyday lives and hobbies. Focusing on the fact that stuffed toys in Nuikatsu usually remain still and silent, we examined whether Sota's pose influences users' level of self-projection and their perceptions of the robot, including anthropomorphism, animacy, and likeability. We also compared indoor and outdoor settings to investigate whether the surrounding environment affects these experiences.

Accordingly, we strive to conduct experiments to answer the following questions:

RQ1. How do robot impressions and the degree of self-projection differ between the customized and non-customized robots?

RQ2. How do robot impressions and the degree of self-projection differ between indoor, more artificial interaction scenes and outdoor, more natural interaction scenes?

II. Method

A. Participants

12 participants, aged from 20 to 30(mean age 24.6±2.6, 6 males and 6 females, being undergraduates, research students or graduate students) took part in this study. Each participant comes from either China or Japan, both among the countries listed as examples in *Introduction*, in which Nuikatsu is known as a trend among young people. Ethical approval for this research was obtained from the Ethics Review Committee of the Institute of Library, Information and Media Sciences at the University of Tsukuba(Approval No. 25-75), and written consent was obtained from the participants before joining this study.

B. The Use of Pose in Experiment

In this study, we focused on pose customization because Nuitori captures a still pose rather than a continuous motion. Previous HRI studies have shown that robot motions and gestures can influence users' perceptions [10], [11], suggesting that pose may also affect users' impressions of a robot. We therefore compared two pose conditions: a user-customized pose and a default pose, in which Sota faced straight ahead with both arms lowered.

C. Robot Characteristics and Scenarios

The robot we used in this study is the robot Sota [12], a humanoid robot with the size of 280(H) × 140(W) × 160(D)mm and weighs approximately 800 grams. It has 8 degrees of freedom in total, with rotatable arms and elbows, neck and a torso, enabling it to be customized to perform a variety of poses. For pose customization, we chose an intuitive way: to directly move its parts to customize a pose. The degrees of freedom, along with ways to customize the robot's poses are introduced before the interaction process in order to let participants better know the robot and how to customize to the preferred poses.

D. Experiment Scenarios

Each experiment includes two interaction scenes, both indoor and outdoor. The indoor environment(laboratory) is relatively more artificial than the outdoor environment(park). The laboratory is a room of approximately 20 square meters, and has casual office equipment including tables, PCs, shelves, refrigerators, etc. The park(The Central Park of Tsukuba), is a relatively more natural environment with lakes surrounded by trees, while also having institutions like the Tsukuba Expo Center in the vicinity.

E. Procedure

The customized and default pose, as well as the indoor and outdoor environment, makes 2 $\times$ 2 = 4 combinations of conditions. We arranged our experiment order according to the Latin's square [13], dividing the recruited 12 participants equally into 4 groups, each experiencing a different order of combinations. Groups and orders are listed in Table I:

TABLE I: Experimental condition order for each group

Group	Step 1	Step 2	Step 3	Step 4
Group 1	Indoor/Customized	Indoor/Default	Outdoor/Customized	Outdoor/Default
Group 2	Indoor/Default	Indoor/Customized	Outdoor/Default	Outdoor/Customized
Group 3	Outdoor/Customized	Outdoor/Default	Indoor/Customized	Indoor/Default
Group 4	Outdoor/Default	Outdoor/Customized	Indoor/Default	Indoor/Customized

First, the participant listens to a brief introduction of Nuikatsu, the robot Sota, and how to customize Sota's poses. Next, the participant customizes Sota to a pose that can represent him or herself. After that, the participant answers basic information including age, gender, whether he or she has experiences of Nuikatsu, and why does he or she considers the customized pose to represent him or her.

The above procedures are the same from Group1 to Group 4, while the following steps vary among each group. Here is an example of Group 1's order of the following steps:

1) Explore the indoor environment, putting the customized robot in various places, and take at least 5 photos of the robot. Afterwards, answer the questionnaire.
2) Explore the same indoor environment, putting the robot with the default pose in various places, and again take at least 5 photos. Afterwards, answer the questionnaire.
3) Explore the outdoor environment following a decided route, putting the customized robot in various places, and take at least 5 photos. Afterwards, answer the questionnaire.
4) Explore the outdoor environment following the same route, putting the robot with the default pose in various places, and take at least 5 photos. Afterwards, answer the questionnaire.

Finally, the participant submits photos taken during the interactions for further analysis.

F. Data and Measures

Four questionnaires with the same content are used, while basic information, containing age, gender, experience of Nuikatsu, and reason for customization, only needs to be answered once in the beginning.

The self-projection part of the questionnaire measures participants' identity overlap with the robot. Here, the Inclusion of Others in the Self Scale, or the IOS Scale [14] is used and adapted, as we adapted the circle standing for "other" to "robot".

The perception part measures the impression participants have towards the robot. We used the Godspeed questionnaire series [15], and selected the concept of anthropomorphism, animacy and likeability. Some adaptations are made to fit better into our experimental conditions. Since the robot remains still after the pose is decided, we deleted the scales

(a) (b)

Fig. 1: Examples of the photo pose

(a) (b) (c) (d)

Fig. 2: Examples of the character pose

of "Inert-Interactive" and "Apathetic-Responsive" in animacy, and "Moving Rigidly-Moving Elegantly" in anthropomorphism.

III. Results and Findings

A. Customized Poses and Reasons

As introduced in *Method*, in the questionnaire we asked "why does this pose represent yourself". The answers(poses) showed a great variety, and we can hardly find two identical answers(poses). However, we can still find some interesting common points.

The first common point is the "photo pose"(Shown in Figure 1). 2 participants linked the customized poses with the poses they themselves make while being photographed.

For the pose in Figure 1(a) the participant explained "I use this pose for taking photo in daily life.", for the pose in Figure 1(b) the explanation was "Because I use the same pose for taking photos."

Another common point is the "character pose"(Shown in Figure 2). 4 participants explained their own characters and linked their characters with the customized poses.

For the pose in Figure 2(a) the participant explained "This pose represents my kind character.", and for the pose in Figure 2(b) the explanation was "Because it represents my lively and optimistic character.", and "Because the angle of the head shows the curiosity and with the arm risen, showing my passion and encouragement to myself and others." for the pose in Figure 2(c), "Because I am an intrinsic person, and most of the time I am in a thinking state or with a lot of thoughts, so I chose this pose."for the pose in Figure 2(d).

The rest 6 of our participants used explanations that differed to an extent beyond our ability to categorize, and for example, terms like "Because it shows me feeling the world", "Because it looks cool" as well as "It shows me looking at the smartphone" were used for explanations.

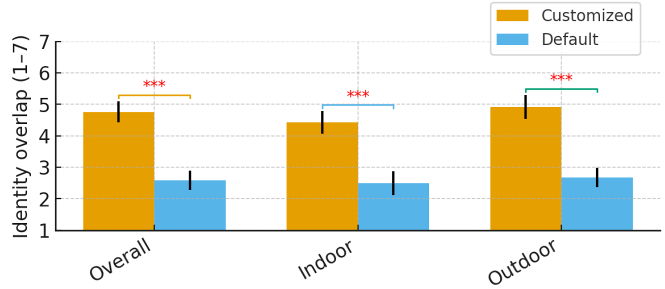

Fig. 3: Degree of identity overlap

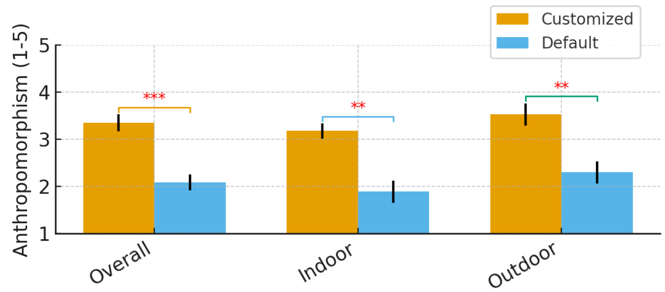

Fig. 4: Anthropomorphism

B. Overlap of Identity

As mentioned in *Method*, we used an adapted IOS Scale that measures the degree(from 1 to 7) of identity overlap between the participant and the robot. From Figure 3 that visualizes our result, we can see that in overall condition(calculated by the average of indoor and outdoor condition), the degree of identity overlap from the customized pose condition(M=4.76, SE=0.34) is higher than the default pose condition(M=2.58, SE=0.31). A Wilcoxon signed-rank test showed a statistically significant difference ($p < .001$).The same pattern appeared in both indoor (customized: M=4.42, SE=0.36; default: M=2.50, SE=0.38, $p < .001$) and outdoor settings (customized: M=4.92, SE=0.38; default: M=2.67, SE=0.31, $p < .001$).

Accordingly, the results showed that a robot that has a customized pose did gave our participants a stronger effect of self-projection in overall, as well as both indoor and outdoor environments.

On the other hand, when comparing environments within the same pose type, no significant differences were observed between indoor and outdoor conditions for either the customized pose ($p > .05$) or the default pose ($p > .05$).

C. Impressions Toward the Robot

1) Comparing Anthropomorphism(see Figure 4): Anthropomorphism ratings were analyzed using the Wilcoxon signed-rank test. Across all environments, the customized pose consistently received higher scores than the default pose. Overall, the customized pose (M=3.34, SE=0.18) exceeded the default pose (M=2.08, SE=0.17, $p < .001$). The same pattern appeared in both indoor (customized: M=3.17, SE=0.16; default: M=1.88,

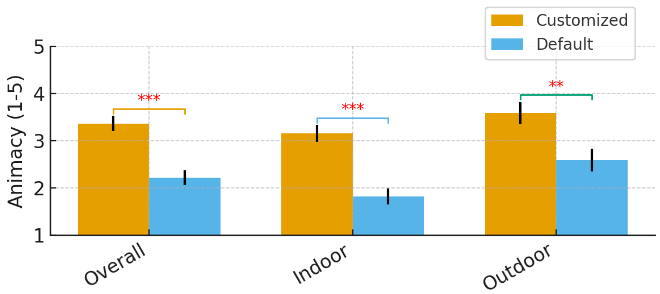

Fig. 5: Animacy

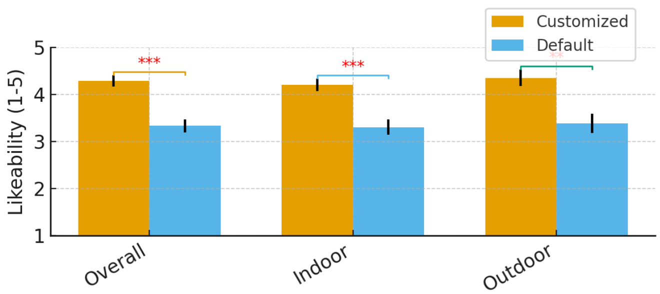

Fig. 6: Likeability

SE=0.24, $p < .01$) and outdoor settings (customized: *M*=3.52, *SE*=0.24; default: *M*=2.29, *SE*=0.23, $p < .01$).

When comparing environments within the same pose type, no significant differences were observed between indoor and outdoor conditions for either the customized pose ($p > .05$) or the default pose ($p > .05$).

2) Comparing Animacy(see Figure 5): Animacy ratings were analyzed using the Wilcoxon signed-rank test. Across all environments (Figure 10), the customized pose consistently received higher scores than the default pose. Overall, the customized pose (*M*=3.36, *SE*=0.16) exceeded the default pose (*M*=2.21, *SE*=0.16, $p < .001$). The same pattern appeared in both indoor (customized: *M*=3.15, *SE*=0.18; default: *M*=1.81, *SE*=0.17, $p < .001$) and outdoor settings (customized: *M*=3.58, *SE*=0.24; default: *M*=2.58, *SE*=0.24, $p < .01$).

When comparing environments within the same pose type, no significant differences were observed between indoor and outdoor conditions for either the customized pose (p ¿.05) , while the default pose ($p < .05$) showed some significancy.

3) Comparing Likeability(see Figure 6): Likeability ratings were analyzed using the Wilcoxon signed-rank test. Across all environments (Figure 9), the customized pose consistently received higher scores than the default pose. Overall, the customized pose (*M*=4.28, *SE*=0.12) exceeded the default pose (*M*=3.33, *SE*=0.14, $p < .001$). The same pattern appeared in both indoor (customized: *M*=4.20, *SE*=0.13; default: *M*=3.30, *SE*=0.16, $p < .001$) and outdoor settings (customized: *M*=4.35, *SE*=0.17; default: *M*=3.38, *SE*=0.20, $p < .01$).

When comparing environments within the same pose type, no significant differences were observed between indoor and outdoor conditions for either the customized pose ($p > .05$) or the default pose ($p > .05$).

IV. Discussion

Our results suggest that pose customization can strengthen both users' self-projection into a companion robot and their positive perceptions of the robot. Compared with the default pose, the user-customized pose led to higher identity overlap, anthropomorphism, animacy, and likeability in both indoor and outdoor settings. This indicates that even when a robot is not actively moving or interacting, its static pose can still influence how users relate to it.

The effect of environment was relatively limited. Although this study included both an indoor laboratory and an outdoor park, most measures did not show significant differences between the two settings. Therefore, pose customization may have a more direct influence on user perception and self-projection than the surrounding environment in Nuikatsu-like activities.

These findings suggest a simple design implication for companion robots: allowing users to create, save, or maintain personalized poses may help robots fit more naturally into everyday activities. For example, a companion robot could keep a user-customized pose when it is in sleep mode, being carried, or placed in a personal environment for taking photos.

This study also has several limitations. First, we used only one robot, Sota, so the results may differ with robots of other shapes, sizes, or degrees of freedom. Second, we did not directly compare robots with stuffed toys, although Nuikatsu originally involves stuffed toys. Third, the sample size was small, which may have limited our ability to examine environmental effects. Future work should include more participants, compare robots with stuffed toys, and further analyze the photos taken by participants, such as whether the robot faces the camera or interacts with the surrounding environment.

V. Conclusion

This study explored the effect of user-customized robot poses in Nuikatsu-like activities. The results showed that customized poses increased users' self-projection, anthropomorphism, animacy, and likeability toward the robot, while indoor–outdoor differences were limited. These findings suggest that customizable static poses may be a simple but useful design feature for everyday companion robots.

Acknowledgments

This work was supported by JSPS KAKENHI Grant Number JP23K12810.

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