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Effects of a robot's head-tilting motion and hand gesture on the feeling of *kawaii* toward the robot and its outfit

Masahiro Shiomi[a]*, Yuina Kato[b], Hiroshi Nittono[c], Emi Anzai[b], and Naoki Saiwaki[b]

[a] *Interaction Science Laboratories, ATR, Seika-cho, Kyoto, Japan*

[b] *Nara Women's University, Nara, Japan*

[c] *The University of Osaka, Suita, Japan*

*Corresponding author: Masahiro Shiomi, m-shiomi@atr.jp

Masahiro Shiomi received M. Eng. and Ph.D. degrees in engineering from Osaka University in 2004 and 2007, respectively. During that time, he was an intern researcher at the Intelligent Robotics and Communication Laboratories (IRC). He is currently a group leader in the Agent Interaction Design Department at the Interaction Science Laboratories (ISL) and Interaction Technology Bank (ITB) at the Advanced Telecommunications Research Institute International (ATR). His research interests include human-robot interaction, social touch, robotics for childcare, networked robots, and field trials.

Yuina Kato received her bachelor's degree in Human Life and Environment in 2023 from Nara Women's University, Nara, Japan. Her research interests include human-robot interaction.

Hiroshi Nittono received his PhD in Human Sciences from Osaka University in 1998. He was an associate professor at Hiroshima University from 2005 to 2016 and is currently full professor of General Psychology and director of the Cognitive Psychophysiology Laboratory at the University of Osaka. His research interests revolve around experimental studies of cognitive, emotional, and motivational processes in humans using psychophysiological measures.

Emi Anzai received her master's degree in science in 2014 and her Ph.D. in 2017, both from Ochanomizu University, Tokyo, Japan. In 2016, she was a visiting scholar at La Trobe University, Australia. She is currently a lecturer in the Faculty of Engineering at Nara Women's University, Nara, Japan. Her research interests focus on human informatics and wearable sensors, particularly their applications in elderly care, healthcare, welfare, and daily life.

Naoki Saiwaki received his Ph.D. in engineering in 1998. He is currently a full professor and advisor to the President at Nara Women's University, as well as a specially appointed professor

at Osaka University. His research interests focus on human interfaces, human informatics, wearable sensors, e-textiles, and intelligent interactive systems.

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Head-tilting motions are notable social cues that have a significant impact on human-robot interaction, since prior studies suggest they can enhance the feeling of *kawaii* given by a robot. *Kawaii*, a Japanese term referring to cuteness or endearment, is an emotional response that has proven critical for designing socially acceptable robots. However, the influence of head-tilting characteristics remains underexplored. Therefore, we investigate how variations in both the speed and direction of head-tilting motion affect the feeling of *kawaii*, as well as investigate the effectiveness of hand gestures during the motion. Moreover, we explore whether the *kawaii* characteristics of an object can be transferred to its surrounding objects, i.e., the *kawaii* spillover effect, by using the robot and its outfits. We conduct web surveys for three different purposes. First, the feeling of *kawaii* toward the robot is enhanced when it tilts its head to its right (from participant's viewpoint) within 0.5 to 1 second. Second, the hand gesture (hands-on-cheeks) along with the head-tilting motion also enhances the feeling of *kawaii* toward the robot. Finally, this head-tilting motion with the hands-on-cheeks gesture increases the feeling of *kawaii* toward the robot and its outfit, as evidence of the *kawaii* spillover effect.

Keywords: *Kawaii*; cuteness; head-tilting; hands-on-cheeks; social robot; *kawaii* spillover effect

1. Introduction

Head-tilting motion, sometimes referred to as head cocking or head canting, is a social signal observed in both humans and animals, reflecting varied intentions across different species. Among humans, head-tilting motions have been linked to ingratiation or appeasement by minimizing apparent body size [1, 2] and to expressing courtship intentions [3, 4]. It has also been associated with enhanced perceptions of attractiveness and trustworthiness [5, 6], increased friendliness [7, 8], and submissiveness [9, 10]. In primates, head-tilting motions often correspond to visually examining objects or

concentrating on novel stimuli [11], and recent work has uncovered parallel effects in dogs [12], including increasing the impression of cuteness [13].

Researchers have begun exploring ways to improve the feeling of *kawaii* toward social robots. Previous design concepts, including the baby schema (i.e., prototypical features of infants or young animals [14, 15]) and the broader feeling of *kawaii* [16-18], have informed automotive and robot design [19-22]. The emotion of *kawaii* typically evokes positive responses, such as smiling and nurturing behaviors [17, 23-26]. For instance, a robot's physical contact with an object can amplify the feeling of *kawaii* [27]. In addition, creating positive interactions among multiple robots can heighten the feeling of *kawaii* [28], and robot-robot interaction via the passive-social style increases the feeling of *kawaii* [29]. Related to robot head-tilting motions, one past study reported that gestures could increase a robot's perceived cuteness [30], an attribute that fosters the development of socially acceptable robots [31-33]. These studies suggest that head-tilting motions are not merely a culturally symbolic expression of cuteness, but rather a universal gesture capable of eliciting physiological and psychological responses across various cultural backgrounds.

However, earlier work on head-tilting motions by robots relied on static depictions [30]. The gesture parameters of head-tilting motions remain relatively unexplored, making them a solid starting point for parametrising motion. A parameter set for effective head-tilting motions could be applied to a wide range of contemporary social robots that have face features with multiple DOFs. A key variable here is gesture speed, which is an important element for crafting natural behaviors in human-robot interaction [34-36]. To realize more effective head-tilting motions by robots, investigating how these gesture parameters influence users' affective states, including the feeling of *kawaii*, would be essential. Furthermore, rather than just investigating the parameters of

the head-tilting motions, conducting exploratory research on accompanying movements that make head-tilting motions more effective.

Moreover, to better understand the effect of head-tilting motions on the feeling of *kawaii*, investigating the *kawaii* spillover effects in the context of using robots, i.e., whether the *kawaii* characteristics of an object (a robot) can be transferred to its surrounding objects (related to the robot), would be important for a deeper understanding of designing acceptable robots. Because the spillover effect in social robots has been investigated in several studies, e.g., how people's impressions or attitudes toward robots propagate impressions or attitudes toward their services or tasks [37-40]; however, this has not yet been studied in the context of the feeling of *kawaii*. Therefore, we also investigated whether impressions of a robot's items change due to the impression of the robot by using multiple outfits for the robot to wear, as well as head-tilting motions with hand gestures.

Taking these considerations into account, we conduct a series of studies consisting of three experiments: 1) parameters of head-tilting motions, 2) additional gestures, and 3) *kawaii* spillover effects. We first explored how variations in the head-tilting motion's speed and direction could strengthen the feeling of *kawaii* (Experiment 1 for RQ1: What parameters are needed for head-tilting motions to increase the feeling of *kawaii*?). We next investigated whether incorporating different hand gestures (i.e., hands-on-cheeks) along with head-tilting motions further optimizes the design for social robots, based on the gathered data from Experiment 1 (Experiment 2 for RQ2: Does the hands-on-cheeks gesture increase the feeling of *kawaii*?). Finally, we investigated whether head-tilting motions with hands-on-cheeks gestures could enhance the feeling of *kawaii* toward the robot's outfits (Experiment 3 for RQ3: Does the feeling of *kawaii* toward the robot enhance the feeling of *kawaii* toward its outfit as a spillover effect?).

Although this paper is an extended version of previous work by Shiomi et al. [41], we added a new research question from the perspective of clarifying the spillover effect; accordingly, this paper contains an additional experiment, an analysis of its results, and more detailed discussions with related works.

2. General Method

Since this study consists of three experiments utilizing similar materials, we first describe information common to all experiments. Unique details specific to each experiment are provided separately in their respective sections.

2.1 Visual Stimuli

We prepared video stimuli featuring Sota, a desktop-sized social robot measuring 28 cm in height. The robot has two arms (each with two degrees of freedom), two LED eyes, and a speaker with an LED mouth synchronized to the speaker's volume. We selected SOTA due to its head mobility, enabling it to perform head-tilting motions comparable to those of robots used in previous studies investigating similar effects [30]. Its compact size and ease of accessibility were additional reasons for this choice.

All videos were recorded at a resolution of 1920 × 1080 pixels and 30 frames per second. Following previous research recommendations [30], the robot's head was tilted to approximately 20 degrees; due to hardware constraints, the actual tilt was about 17–18 degrees.

2.2 Measurements

We administered two validated and reliable questionnaire items to evaluate the feeling of *kawaii* toward the robots based on a past study [25]: (1) a direct measure of how *kawaii* they perceived the robot to be ("the degree of the feeling of *kawaii*") and (2) a measure of how much they felt inclined to approach the robot ("the degree of

wanting to approach"). Both items used a 1–7 rating scale, with 1 indicating "not *kawaii* at all," or "completely disagree," and 7 indicating "extremely *kawaii*, or "completely agree."

2.3 Procedure

The Advanced Telecommunication Research Review Boards (21-501-3) approved our experimental procedures. Participants were first briefed on the experiment's aims and the criteria for evaluating each video. We employed a within-participant design, i.e., they viewed all video clips in a randomized order, responding to the same set of items for each clip. Then, they answered supplementary questions designed to verify the quality of their responses (e.g., screening items [42, 43]). For example, we included instruction-manipulation checks in which they were told to skip certain items. Participants who did not follow these instructions were excluded from the dataset.

2.4 Participants

We recruited participants through a Japanese commercial survey company. Each participant took part in only one experiment, and no participant was allowed to participate multiple times.

3. Experiment 1: Effects of Speed and Direction

3.1 Overview

This first experiment examined how variations in head-tilting motions' speed and direction affect the feeling of *kawaii* toward a robot. Because we approached RQ1 (What parameters are needed for head-tilting motions to increase the feeling of *kawaii*?) in an exploratory manner, we did not establish specific hypotheses in advance.

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3.2 Visual stimuli and conditions

We created a set of 5-second video clips featuring Sota tilting its head under different speeds and directions. Specifically, we employed four gesture-duration settings (*speed* factor: *0.1 s*, *0.5 s*, *1 s*, and *2 s*) and two directions (*direction* factor: *leftward* or *rightward*, defined from the observers' perspective rather than the robot's as shown in Fig. 1), resulting in eight conditions. Figure 1 displays sample frames of these head-tilting motions.

Leftward Front Rightward

Figure 1. Head-tilting motions of the robot

3.3 Measurements

In addition to the two questionnaire items described in Section 2.2, we administered one binary question, where participants indicated whether they preferred the robot's head to tilt left or right. They could also submit free-description input to suggest additional gestures that might enhance the feeling of *kawaii* toward robots.

3.4 Procedure

In this experiment, the participants viewed all eight video clips in a randomized order and answered the questionnaires. After completing these evaluations, participants answered the binary question (i.e., the preferred direction of the head-tilting motion) and gave suggestions by free-description input.

3.5 Participants

Before conducting the experiment, we performed an a priori power analysis using G*power [44] (small effect size = 0.10, power = 0.95, and $\alpha = 0.05$). The required sample size was 138 participants. Thus, we recruited 205 Japanese participants (102 women, 103 men, mean age 42.65 years), anticipating potential exclusions. After applying the above screening criteria, 177 participants (88 women, 99 men, mean age 43.29 years) remained in the final dataset.

3.6 Results

We conducted a two-factor repeated-measures analysis of variance (ANOVA) on the ratings obtained for the feeling of *kawaii*, with the *speed* factor (*0.1 s*, *0.5 s*, *1 s*, and *2 s*) and the *direction* factor (*leftward* or *rightward*). As shown in Fig. 2-left, the *speed* factor exerted a significant main effect ($F(3, 528) = 79.664$, $p < 0.001$, partial $\eta^2 = 0.312$), but no significant effect was shown for the *direction* factor ($F(1, 176) = 3.490$, $p = 0.063$, partial $\eta^2 = 0.019$) and the interaction ($F(3, 528) = 1.112$, $p = 0.344$, partial $\eta^2 = 0.006$). Post-hoc Bonferroni tests revealed significant pairwise differences across most speed levels, except between *0.5 s* and *1 s* ($p = 0.810$): *0.1 s* vs. *0.5 s* ($p < 0.001$), *0.1 s* vs. *1 s* ($p < 0.001$), *0.1* s vs. *2 s* ($p < 0.001$), *0.5 s* vs. *2 s* ($p < 0.001$), and *1 s* vs. *2 s* ($p < 0.001$).

Another ANOVA on the ratings for degree of wanting-to-approach (Fig. 2-right) produced similar results; the *speed* factor exerted a significant main effect ($F(3, 528) = 97.722$, $p < 0.001$, partial $\eta^2 = 0.357$), but no significant effect was observed for the *direction* factor ($F(1, 176) = 1.221$, $p = 0.271$, partial $\eta^2 = 0.007$) and the interaction ($F(3, 528) = 1.116$, $p = 0.342$, partial $\eta^2 = 0.006$). Post-hoc Bonferroni tests revealed significant pairwise differences across most speed levels, except between *0.5 s* and *1 s*

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($p = 1.000$): *0.1 s* vs. *0.5 s* ($p < 0.001$), *0.1 s* vs. *1 s* ($p < 0.001$), *0.1 s* vs. *2 s* ($p < 0.001$), *0.5 s* vs. *2 s* ($p < 0.001$), and *1 s* vs. *2 s* ($p < 0.001$).

We conducted a two-tailed binominal test on participants' left-or-right tilt preference (Fig. 3). The results show that participants significantly preferred the rightward tilt to the leftward one (leftward: 40 participants, rightward: 137, (p <.0.01)).

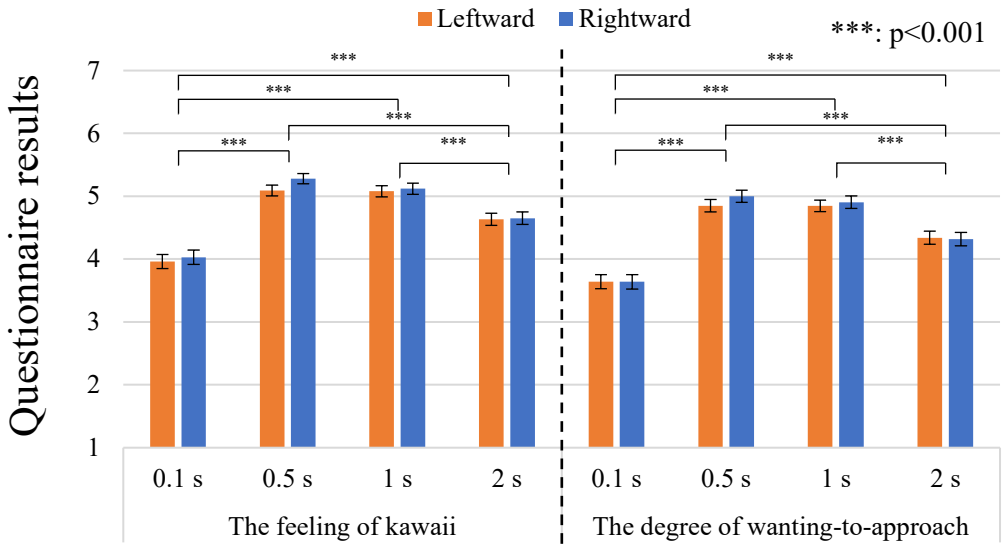

Figure 2. Mean ratings for the feeling of *kawaii* (left) and the degree of wanting-to-approach (right) from Experiment 1

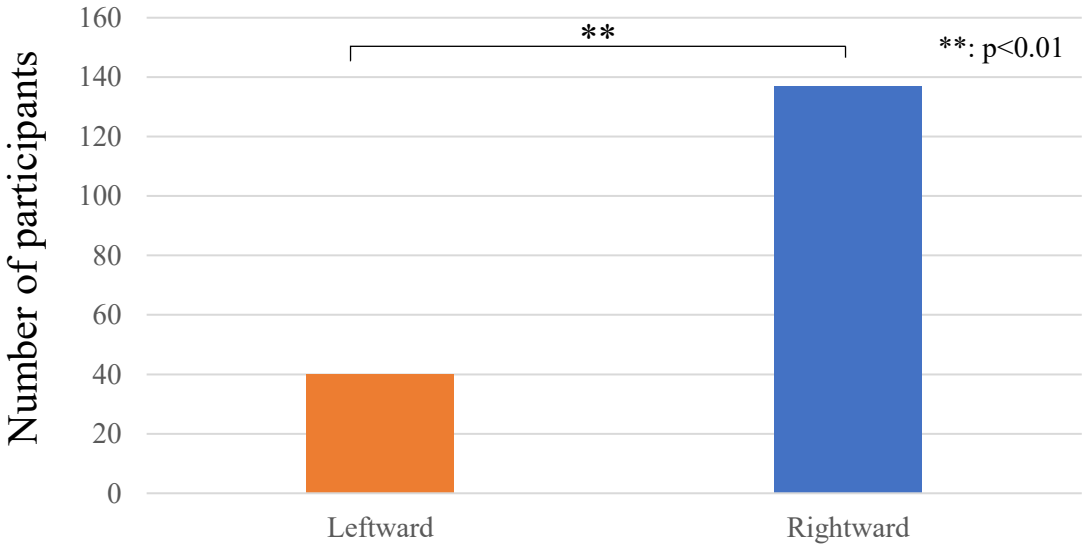

Figure 3. Number of participants stating each preference in the direction (left/right) of the head-tilting motion

3.7 Free-description analysis

We collected 178 open-ended comments and then classified them into four themes: hand gestures, head gestures, other movements (e.g., dancing), and infeasible requests (e.g., facial expressions not supported by our robot). Of these, 87/104 suggestions involved adding hand gestures, mostly generic tips like "raising a hand." Furthermore, 17/104 participants specified a particular movement, such as "placing hands on the cheeks." Meanwhile, 26 comments recommended additional head actions (e.g., nodding or bowing) that are unrelated to head-tilting motions. A few participants suggested dancing or changes in LED colors, while 41 requests were technically infeasible under our current setup (e.g., attaching animal ears or tails).

3.8 Discussion

Our findings highlight three practical considerations. First, we observed that a head-tilting motion's duration between 0.5 s and 1 s appears optimal for eliciting the feeling of *kawaii*. This insight expands on prior research that used only static images [30]. Second, although there were no direction-based differences in the feeling of *kawaii* or in the approachability questionnaire items, significantly more participants preferred a rightward tilt in the binary selection between left and right. This preference for right tilts partly aligns with previous work, indicating possible asymmetries in trustworthiness or attractiveness [5]. Our data thus indicate that people's explicit preferences can diverge. Finally, numerous participants mentioned the potential benefits of complementary hand gestures (e.g., hands-on-cheeks), motivating us to further examine combined head-tilting motions and hand gestures. We incorporated these

findings into the design of Experiment 2, using the better tilt speed and direction from Experiment 1.

4 Experiment 2: Effects of Hand Gestures

4.1 Overview

Our second experiment focused on RQ2 (Does the hands-on-cheeks motion increase the feeling of *kawaii*?), i.e., we examined how "hands-on-cheeks" gestures, inspired by the free-description responses from Experiment 1, could complement head-tilting motions to enhance the feeling of *kawaii*. Specifically, we investigated whether these combined movements would further enhance the feeling of *kawaii*, building on the findings on motion speed and direction from Experiment 1.

4.2 Hypotheses and Predictions

Through Experiment 1, multiple participants suggested the effectiveness of the hands-on-cheeks gestures on the feeling of *kawaii*. In fact, past related studies also suggested such effects: Covering the face with the hands might change facial impressions by hiding its shape, resulting in a slim and small chin, which is related to attractive facial features [45, 46] and the baby scheme [14, 15]. Moreover, a previous study identified face-covering gestures as a cue for cuteness in image-processing tasks [47], while several works in East Asian settings have noted that such gestures may enhance perceived cuteness [48-51]. These studies also suggest that face-covering gestures are not merely a culturally symbolic expression of cuteness in Japan. In that context, the use of both hands might further enhance the feeling of *kawaii*. Based on these considerations, we propose the following predictions:

Prediction 1: Participants more positively evaluate a robot with a hand-on-cheek (single hand) gesture than a robot without this gesture.

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Prediction 2: Participants more positively evaluate a robot with a both-hands-on-cheeks gesture than robots with an either-hand-on-cheek gesture.

4.3 Visual stimuli and conditions

We created a set of 5-second video clips featuring the Sota robot tilting its head under different hand gestures. Specifically, we employed four different gesture conditions (*gesture* factor): *no* (no hand gesture), *left* (left-hand-on-left-cheek), *right* (right-hand-on-right-cheek), and *both* (both-hands-on-both cheeks). The head direction was *right* from the participants' viewpoint, and the head-tilting motion's speed was 0.5 s based on the results from Experiment 1. Figure 4 displays sample frames of these hand gestures.

Figure 4. Rightward head-tilting motion with different hand gestures

4.4 Measurements

We administered the two questionnaire items described in Section 2.2 (the degree of the feeling of *kawaii* and the degree of wanting-to-approach)

4.5 Procedure

In this experiment, the participants viewed all four video clips in a randomized order and answered the questionnaires.

4.6 Participants

As it was designed as a follow-up to Experiment 1, we recruited a similar number of participants; a total of 215 Japanese participants (108 women, 103 men, 4 who declined to specify, mean age 42.84 years) were recruited. After applying the above screening criteria, 193 participants (95 women, 94 men, 4 who declined to specify, mean age 42.56 years) remained in the final dataset.

4.7 Results

We conducted a one-factor repeated-measures ANOVA on the ratings for feeling of *kawaii*, using the *gesture* factor. As shown in Fig. 5-left, the *gesture* factor exerted a significant main effect ($F(3, 576) = 15.411$, $p < 0.001$, partial $\eta^2 = 0.074$). Post-hoc Bonferroni tests revealed significant pairwise differences: *no* and *left* (*no* < *left*, $p = 0.005$), *no* and *both* (*no* < *both*, $p < 0.001$), *no* and *right* (*no* < *right*, $p = 0.008$), *left* and *both* (*left* < *both*, $p = 0.003$), and *right* and *both* (*right* < *both*, $p = 0.002$). Since no a priori sample size calculation was conducted for this follow-up experiment, we performed a post hoc power analysis after data collection. Statistical power exceeded 0.80 for both measurements (correlations among repeated measures for both values were 0.8), satisfying typical standards for statistical analyses.

Another ANOVA on the ratings for degree of wanting-to-approach (Fig. 5-right) revealed that the *gesture* factor again exerted a significant main effect ($F(3, 576) = 14.762$, $p < 0.001$, partial $\eta^2 = 0.071$). Post-hoc Bonferroni tests revealed significant pairwise differences: *no* and *left* (*no* < *left*, $p < 0.001$), *no* and *both* (*no* < *both*, $p < 0.001$), and *no* and *right* (*no* < *right*, $p < 0.001$).

Therefore, prediction 1 was supported, since participants positively evaluated robots using hand-on-cheek gestures more than robots that did not use them, from the viewpoints of both the feeling of *kawaii* and the wanting to approach. On the other

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hand, prediction 2 was only partially supported, since participants more positively evaluated a robot with a both-hands-on-cheeks gesture than one with an either-hand-on-cheek gesture only from the viewpoint of the feeling of *kawaii* only, not the wanting to approach.

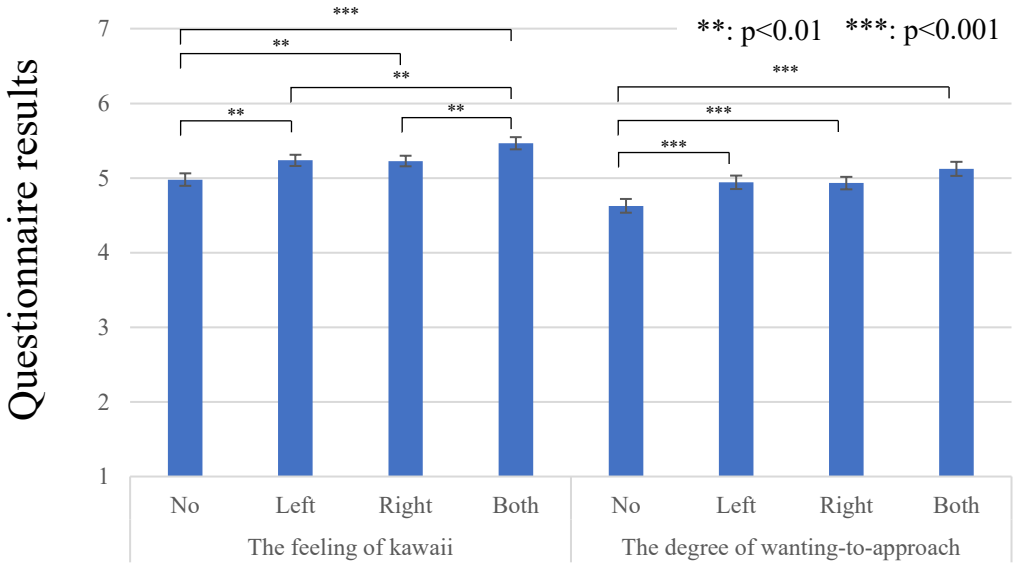

Figure 5. Mean ratings for the feeling of *kawaii* (left) and the degree of wanting-to-approach (right) from Experiment 2

4.8 Discussion

Our experimental results provide a useful hint for designing hands-on-cheeks gestures. The experiment results show that the hand gestures (putting hands on cheeks) suggested by the participants in Experiment 1 effectively increased the feeling of *kawaii* and the degree of wanting-to-approach. Although the provided comments did not specify which hand should make the gesture, the results of our investigation, which considered all combinations, reveal the advantage of using both arms for the purpose of evoking the feeling of *kawaii*.

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5 Experiment 3: Spillover effect of *kawaii*

5.1 Overview

In Experiment 3, we extended our investigation of the head-tilting motions with the hands-on-cheeks gesture to spillover effects, from the robot itself to its related items. For this purpose, we focused on outfits because recent work has shown that robot outfits can help define a robot's social role [52], and with the emergence of commercial clothing for pet-like robots [53], outfits for robots are becoming everyday items. Therefore, to answer RQ3 (Does the feeling of *kawaii* toward the robot enhance the feeling of *kawaii* toward its outfit as a spillover effect?), we prepared videos in which a robot demonstrates different fashion styles in combination with *kawaii* movements.

5.2 Hypotheses and Predictions

Several studies have reported that the attractiveness of people in service settings, such as salesclerks and news anchors, influence consumer behaviors, product attractiveness, or attitudes [54-56]. Such phenomena have also been reported in situations where the salesclerks are virtual agents, not human beings [57]. These studies suggest spillover effects from people to their related items in the context of positive impressions, which would be useful for robot cases. Our series of experiments show that head-tilting motions with the hands-on-cheeks gesture increased the robot's attractiveness in the context of the feeling of *kawaii*. We assumed that such effects, i.e., enhancing the feeling of *kawaii* of the robot via its gestures, would also positively affect the robot's outfits. Based on these considerations, we propose the following prediction:

Prediction 3: Participants more positively evaluate the feeling of *kawaii* toward a robot's outfits when the robot shows a head-tilting motion with hands-on-cheeks gesture than when a robot that does not use this gesture.

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5.3 Visual stimuli and conditions

We created a set of 17-second video clips featuring Sota outfitted in four different styles (*fashion* factor: *formal*, *boy*, *girl*, and *cute*) under two gesture conditions (*gesture* factor: *with* or *without* a gesture). We decided these outfit styles based on the garment sets commonly offered by the manufacturer (https://www.vstone.co.jp/robotshop/) and its licensed reseller (https://robo-uni.com/collections/sota). The head direction and the head-tilting motion's speed were 0.5 s based on the results from Experiment 1. In each video, the robot introduced its outfits by speaking, performing minor idle motions such as slightly moving its face and arms, and asking, "How *kawaii* do you feel my outfit is?" In the *with* condition, the robot performed the head-tilting motion combined with the hand gestures at that timing. In contrast, in the *without* condition, the robot asked the same question without performing these additional gestures. Figure 6 shows snapshots of the four outfits.

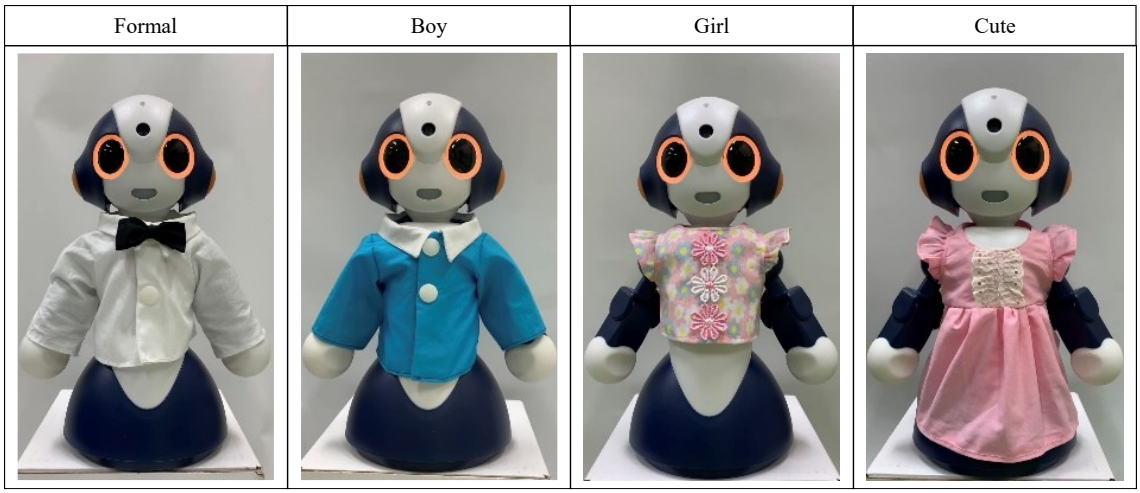

Figure 6. Different types of fashions for Sota (formal, boy, girl, and cute).

5.4 Measurements

In this experiment, we used two items to measure the feeling of *kawaii*: one for the robot's outfits for prediction 3 and the other for its motion as a manipulation check.

Both were rated using a 7-point scale, with 1 indicating "not *kawaii* at all" and 7 indicating "extremely *kawaii*."

5.5 Procedure

In this experiment, the participants viewed all eight video clips in a randomized order and answered the questionnaires.

5.6 Participants

As in Experiment 1, we conducted an a priori power analysis using G*power [44] (small effect size = 0.10, power = 0.95, $\alpha = 0.05$), resulting in a required sample size of 138 participants. Consequently, we recruited 202 Japanese participants (103 women, 98 men, 1 who declined to specify, mean age 41.63 years) to account for potential exclusions. After applying the screening criteria, 179 participants (89 women, 89 men, 1 who declined to specify, mean age 41.43 years) remained in the final dataset.

5.7 Results

As a manipulation check, we conducted a two-factor repeated-measures ANOVA on the ratings for the feeling of *kawaii* toward the robot's motion, using the *fashion* factor (*formal*, *boy*, *girl*, and *cute*) and the *gesture* factor (*with* and *without*). As shown in Fig. 7, the *gesture* factor exerted a significant main effect ($F(1, 178) = 108.932$, $p < 0.001$, *partial η2* = 0.380), but the *fashion* factor ($F(3, 534) = 2.151$, $p = 0.093$, *partial η2* = 0.012) and the interaction ($F(3, 534) = 1.614$, $p = 0.185$, *partial η2* = 0.009) did not exert significant effects. This result again showed the effectiveness of the hands-on-cheeks gesture for the feeling of *kawaii*.

Then, we conducted a two-factor repeated-measures ANOVA on the feeling of *kawaii* ratings toward the robot's outfits, with the *fashion* factor (formal, boy, girl, and cute) and the *gesture* factor (with and without). As shown in Fig. 8, the *fashion* factor

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($F(3, 534) = 5.449$, $p = 0.001$, *partial* $\eta^2 = 0.030$) and the *gesture* factor ($F(1, 178) = 4.340$, $p = 0.039$, *partial* $\eta^2 = 0.024$) exerted significant main effects. However, the interaction was not significant ($F(3, 534) = 0.884$, $p = 0.449$, *partial* $\eta^2 = 0.005$). Post-hoc Bonferroni tests revealed significant pairwise differences across *fashion* levels: boy < formal ($p = 0.026$), girl < formal ($p = 0.014$), and girl < cute ($p = 0.002$). No significant difference was observed between formal and cute ($p = 1.000$), boy and girl ($p = 1.000$), or boy and cute ($p = 0.201$). Accordingly, the feeling of *kawaii* ratings toward the robot's outfits significantly increased when the robot performed the head-tilting motion with hands-on-cheeks pose; prediction 3 was supported.

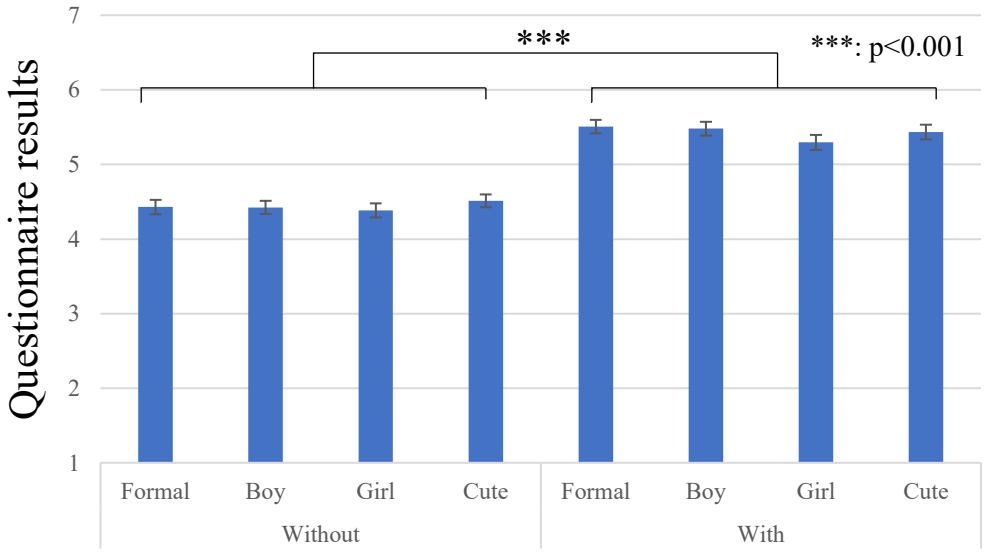

Figure 7. Mean ratings for the feeling of *kawaii* toward the robot's motion

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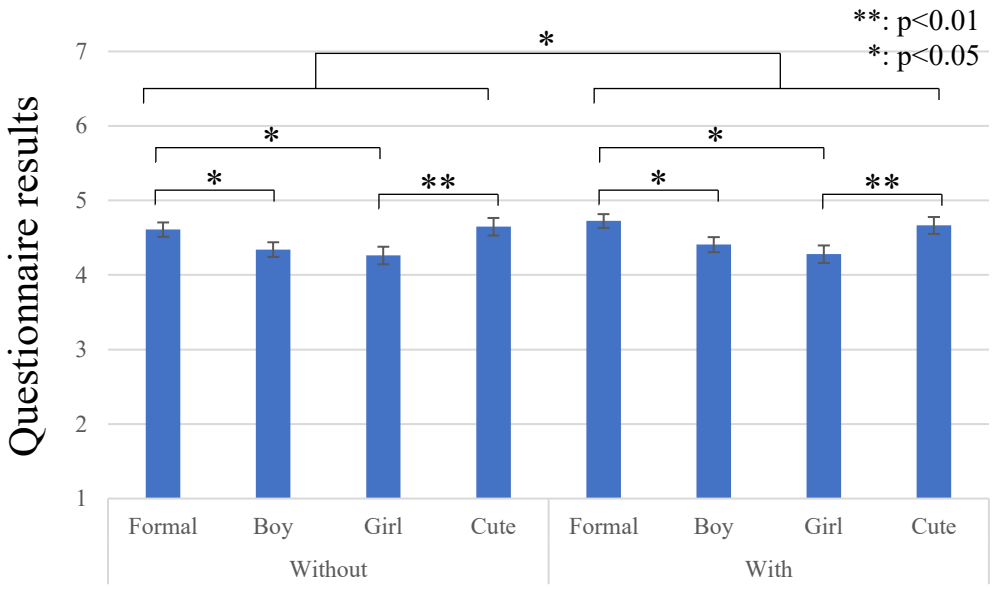

Figure 8 Mean ratings for the feeling of *kawaii* toward the robot's outfits

5.8 Discussion

These results confirm that adding hands-on-cheeks gestures to head-tilting motions can further increase the feeling of *kawaii* toward a robot's outfits, suggesting that the increased feeling of *kawaii* toward the robot influences the impressions of the related items of the robot. Such effects would be useful for robots that work in real environments because these results also suggest that the robot's attractiveness increases the related items' attractiveness. Although the *gesture* factor's effect on outfits seems to be weak compared to its effect on motions, it positively influenced all of them. Likewise, the feeling of *kawaii* toward the robot's motions was consistent with the findings of Experiment 2, reinforcing the utility of combining head-tilting motions and hand gestures.

The experimental results suggest that head-tilting motions remain effective regardless of clothing style (the gesture factor showed a significant main effect). However, the magnitude of the effect may vary across outfits. Although the interaction effect was not statistically significant, head-tilting motions appeared to slightly increase

the feeling of *kawaii* more in the *formal* and the *boy* conditions than in the *girl* and the *cute* conditions. Investigating how outfit styles modulate the spill-over effect of head-tilting motions would be an interesting research topic.

6 General Discussion

6.1 Implications

Through three experiments, our research consistently demonstrated how behavior design supports the feeling of *kawaii*, supplementing prior studies that largely focused on static images or appearances[18, 58, 59]. Our results indicate that a more *kawaii*-oriented robot could also enhance the perceptions of objects or tasks it presents. Earlier work showed that expressing the feeling of *kawaii* toward an object, such as a robot touching it, could enhance the feeling of *kawaii* toward that object [31]. The findings from our study could be combined with such knowledge to promote more natural, appealing interactions.

From another perspective, investigating the negative aspect of the feeling of *kawaii* would be an interesting insight. A previous study reported that high-cute avatars were less effective than low-cute avatars at mitigating the negative effects of conflict between virtual salespeople and online customers [60]. Another study reported that characteristics of "whimsical cuteness" have negative impacts under a non-indulgent context [61]. Our study has not dealt with such conflicting or non-indulgent situations, but an investigation of the effects of the feeling of *kawaii* under such situations deeply would be useful in designing behavioral control rules for more effective advertisement. For example, the robot sales clerk could suppress head-tilting motions with hands-on-

cheeks behaviors during product advertising in conflicting situations or actively use them in non-conflicting situations.

One avenue for future research involves clarifying how the robot's gestures relate to users' impressions of objects in various settings, such as a retail scenario. Although we focused on a small humanoid robot, employing alternative robot forms (e.g., androids [62, 63]) may offer deeper insights into how a robot's attractiveness enhances consumers' evaluations of items [64, 65]. It would also be interesting to investigate how the robot's *kawaii* impressions influenced an item's brand, since a past study reported that cuteness impressions enhance traditional luxury goods' brand equity [66]. Ultimately, identifying gestures that heighten product attractiveness through spillover effects could be relevant for both robot and human salesclerks.

One point worth discussing is the generalizability of our findings across different robot platforms. In this study, we employed only a single robot platform (Sota). Regarding the generalizability of other robots, we expect similar effects of head-tilting motions to be observed in other types of robots as well. A previous study has demonstrated the positive effects of head-tilting motions using various robots, including Telenoid, Kojiro, and ASIMO [30]. These robots share certain human-like characteristics and interactive features (e.g., face) with SOTA, particularly those related to social communication cues. Thus, it is reasonable to assume that similar robots, such as Pepper or NAO, would also yield comparable results.

6.2 Age and gender effects

Previous research has indicated that age and gender influence the feeling of *kawaii*. For example, older adults tend to report a stronger feeling of *kawaii* toward infants, while younger adults typically experience a stronger feeling of kawaii toward objects [67]. Another study also reported that older adults tend to report a stronger

feeling of *kawaii* toward an infant-shaped robot compared to younger adults [68]. Gender differences have also been reported, with women generally reporting a higher feeling of kawaii than men [67]. Since our initial experimental design did not specifically account for these demographic factors, we conducted additional analyses to explore their potential effects on the feeling of *kawaii* associated with head-tilting motions.

We performed supplementary ANCOVA analyses for each experiment, incorporating age as a covariate and gender as an additional factor. In Experiment 1, age demonstrated a significant main effect, although this did not alter the overall pattern of our original findings. The observed results, i.e., older participants felt a greater feeling of *kawaii*, resemble findings from prior research on the baby schema, suggesting that participants may have associated the robot's head-tilting motion with infant-like characteristics. However, age was not a significant factor in Experiments 2 and 3.

Regarding gender, Experiment 1 also showed a significant main effect, consistent with previous findings [67], but there were no interaction effects with the other experimental variables. Additionally, gender did not significantly influence outcomes in Experiments 2 and 3. Thus, gender effects appeared to have limited overall impacts in the context of this study and provided only partial support for existing research [67]. In summary, our findings suggest that age and gender showed similar trends observed in a past study, but there is no novel aspect of the feeling of kawaii elicited by the robot's head-tilting motions.

6.3 Limitations

This study has several limitations. We targeted a single affective dimension (*kawaii*), employed heuristic motion parameters (0.1 s, 0.5 s, 1 s, and 2 s), and tested Japanese participants exclusively. Studies with multicultural participants could easily

expand the range of our findings. Moreover, we focused only on the effects of head-tilting motions, but there remains room to investigate whether other behaviors reported in the free-description responses, such as nodding, bowing, or dancing, have similar effects in enhancing the feeling of *kawaii*. In addition, we could not fully control the participants' viewing conditions (screen size, resolution, viewing distance) in web-based experiments, which may have an influence on the perceived impressions.

Nevertheless, our experiments provide practical guidelines for developers aiming to incorporate *kawaii* motions in human-robot interactions and information-providing tasks. We hope our work serves as a starting point for broader inquiries into *kawaii* design principles.

7 Conclusion

This study focused on how head-tilting motions and supplemental hand gestures affect the feeling of *kawaii*. Across three web-based experiments, we found (1) an optimal speed and direction for head-tilting motions to enhance the feeling of *kawaii*, (2) a further increase in the feeling of *kawaii* when using the both-hands-on-cheeks gesture and (3) a *kawaii* spillover effect, where the *kawaii* characteristics of the robot can be transferred to its outfits. Our results indicate that such movements can influence how users experience both the robot and its presented items, emphasizing the practical value of incorporating *kawaii*-oriented behaviors in social robotics.

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