The Feeling of *Kawaii* toward a Robot's Head-Tilting Motion: Effects of Speed, Direction, and Accompanying Hand Gestures

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Abstract—**Head-tilting motions are social signals that play a key role in communication. In human-robot interaction, researchers have found that this motion increases the observer's feelings of *kawaii* toward a robot. *Kawaii* is a Japanese word meaning cute and adorable, and the feeling of *kawaii* refers to such affectionate, tender feelings toward an object. The feeling of *kawaii* has proven to be crucial for designing socially acceptable robots. However, the impact of the head-tilting speed of social robots on the observer's *kawaii* feelings remains unclear because previous research mainly used static images. This study determined the optimal head-tilting speed and direction to deepen the observer's feeling of *kawaii* toward a robot. Our findings found that participants reported feeling more *kawaii* toward a robot when it tilted its head to its right within 0.5 or 1 second. Our results also showed that gestures associated with head tilting are critical for robot behavior design.**

I. INTRODUCTION

Head-tilting motion, also known as head cocking or head canting, is a social signal exhibited by humans and animals that carries diverse meanings across species. Studies of human head-tilting motions suggest that they function as a form of ingratiation or appeasement, achieved by reducing one's overall body size [1, 2] and complementing courtship displays [3, 4]. Other studies have also found that this motion is related to such affective contexts as perceived attractiveness and trustworthiness [5, 6], friendliness [7, 8], and submissiveness [9, 10]. In animals, particularly primates, head-tilting is typically associated with the visual inspection of objects and a fixation on novel stimuli [11]. In addition, recent research identified an association between head-tilting motions and processing relevant stimuli in dogs that extend beyond primates [12].

How does head-tilting affect the human perception of such artifacts as robots? Researchers have studied this social signal in the context of human-robot interaction, concluding that such motions increase perceptions of cuteness [13]. In human-robot interaction, cuteness is crucial for creating socially acceptable robots [14-16]. For example, researchers have applied a well-known design concept related to perceived cuteness, i.e., the baby schema, which is a set of facial and body features typically found in young animals and babies [17, 18], to automobiles and social robots [19-22]. Similarly, recent robotics research has focused on the concept of *kawaii*, which encompasses cuteness, loveliness, or adorableness and the affective response evoked by objects that possess these characteristics [23-25]. The sensation of *kawaii* is associated with positive emotions and behavioral changes, including smiling and caring [24, 26-29]. A past study reported that touching an object increased the observer's feeling of *kawaii* toward the object [30]. From another perspective, manifesting positive relationships among multiple robots effectively increases feelings of *kawaii* [31].

However, since previous research has primarily used static images [13], there is a gap in applying the effectiveness of head-tilting to social robots. Motion speed is a vital element in creating natural and acceptable robot motions in human-robot interaction [32-34], although previous studies rarely focused on head-tilting motions and their effects on feelings of *kawaii*. By examining motion speed in social robots, our understanding of its impact on *kawaii* feeling and human-robot interaction will improve. As a component of nonverbal communication that plays a crucial role in facilitating effective communication and establishing rapport in human-robot interaction [35, 36], the exploration of head-tilting is critical in this context because it influences feeling of *kawaii* and other affective responses.

In this study, we investigated how head-tilting's speed and direction enhances feelings of *kawaii* (Experiment I). We examined the movement of other body parts, particularly the arms, to determine the optimal hand gesture for accompanying a head-tilting motion to contribute to its effective design in robots (Experiment II). For this purpose, we used a small desktop-sized humanoid robot (Fig. 1) and conducted a series of web surveys.
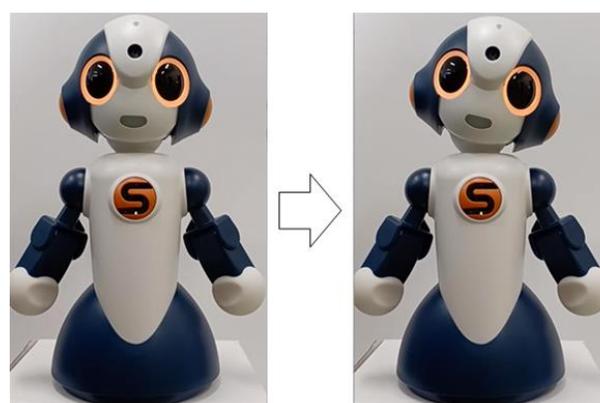
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Figure 1. Robot tilts its head to right (from perspective of participants)

II. EXPERIMENT I

This experiment explored the effects of speed and direction on the feeling of *kawaii* of a robot's head-tilting motion. Since this research question was investigated in an exploratory manner, we did not formulate any specific predictions.

A. Visual stimuli and conditions

We used 5-second videos where a robot tilts its head at varying motion speeds and in different directions. We used a small humanoid robot *Sota*. We prepared eight videos by considering a *speed* factor (four motion-duration conditions: 0.1, 0.5, 1, and 2 seconds) and a *direction* factor (two conditions, left and right, defined from the participant's perspective, not the robot's). Consequently, the motions were essentially identical between conditions, with variations in direction and speed. The tilt angle was approximately 20 degrees, following a previous work [13]. The resolution of each video was 1920 × 1080 pixels. Their frame rates were 30 per second. Fig. 1 shows scenes where the robot tilts its head.

B. Measurements

We employed two questionnaire items to assess how strongly our participants experienced *kawaii:* the feeling of *kawaii* and the degree of wanting-to-approach. These questions demonstrated a strong positive correlation with pleasure [28] and viewing durations in a free-viewing task [28] for the Japanese participants targeted in this study. The items were measured on a 1-to-7 response format, where 1 meant *not kawaii at all* and 7 meant *extremely kawaii*. We prepared a binary question asking participants to indicate their preferred direction for the robot's head (left or right) and also provided a free-text form to gather their opinions about additional movements or behaviors might enhance their feelings of *kawaii* during head-tilting motions.

C. Procedure

The Advanced Telecommunication Research Review Boards (21-501-3) approved our experiment procedures. The participants first read the experiment's explanations and guidelines for evaluating each video. They then viewed all eight videos in different orders and answered questionnaires. The experiment is a within-participant design where the participants watched 4 × 2 (8) videos and evaluated them. The order of the videos was counterbalanced to minimize order effects. Finally, they responded to additional questions to investigate the quality of their answers. Note that past research has identified the necessity for screening processes in web surveys [37, 38]. For this purpose, we used three dummy items using an example instruction manipulation check [38]. The instruction texts asked participants to skip the answers on that page. We removed participants who failed to follow these directions.

D. Participants

The experiment was conducted using the participant pools of a Japanese survey company. 205 people were recruited: 102 women and 103 men whose average age was 42.65. After applying a screening process, which included the above-cited dummy questions, the number of valid participants was reduced to 177: 88 women and 99 men whose average age was 43.29.

E. Questionnaire results

We conducted a two-factor repeated-measures ANOVA with an *LR* factor (left and right) and a *speed* factor (0.1, 0.5, 1, and 2 seconds) for feeling of *kawaii* (Fig. 2). The results showed a significant main effect for the *speed* factor ($F(3, 528) = 79.664$, $p < 0.001$, partial $\eta^2 = 0.312$), but not for the *LR* factor ($F(1, 176) = 3.490$, $p = 0.063$, partial $\eta^2 = 0.019$). The interaction between the *LR* and *speed* factors was not significant ($F(3, 528) = 1.112$, $p = 0.344$, partial $\eta^2 = 0.006$).

Multiple comparisons with the Bonferroni method of simple main effects showed significant differences in the *speed* factor pairwise comparisons: 0.1 seconds vs. 0.5 seconds ($p < 0.001$), 0.1 seconds vs. 1 second ($p < 0.001$), 0.1 seconds vs. 2 seconds ($p < 0.001$), 0.5 seconds vs. 2 seconds ($p < 0.001$), and 1 second vs. 2 seconds ($p < 0.001$). No significant difference was observed between 0.5 seconds and 1 second ($p = 0.810$). The results indicate significant differences in performances across various speed conditions, except between 0.5 and 1 seconds.

We conducted a two-factor repeated-measures ANOVA with the *LR* factor (left and right) and the *speed* factor (0.1, 0.5, 1, and 2 seconds) for the degree of wanting-to-approach (Fig. 3). The results showed significant differences in the *speed* factor ($F(3, 528) = 97.722$, $p < 0.001$, partial $\eta^2 = 0.357$). We found no significant difference in the *LR* factor ($F(1, 176) = 1.221$, $p = 0.271$, partial $\eta^2 = 0.007$) or in the interaction effects ($F(3, 528) = 1.116$, $p = 0.342$, partial $\eta^2 = 0.006$).

Multiple comparisons with the Bonferroni method revealed significant differences between different levels of the *speed* factor: 0.1 seconds vs. 0.5 seconds ($p < 0.001$), 0.1 seconds vs. 1 second ($p < 0.001$), 0.1 seconds vs. 2 seconds ($p < 0.001$), 0.5 seconds vs. 2 seconds ($p < 0.001$), and 1 second vs. 2 seconds ($p < 0.001$). However, we found no significant difference between the *speed factor* levels of 0.5 seconds and 1 second ($p = 1.000$).

We conducted a two-tailed binominal test for the preferences of the head-tilt directions (left: 40, right: 137, Fig. 4) and found a significant difference between the left and the right ($p < .0.01$).
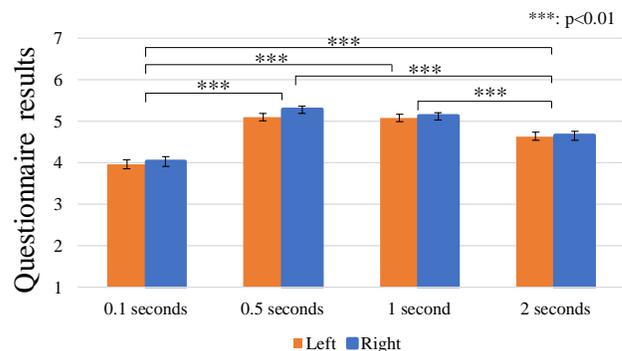

Figure 2.   Means and standard errors of questionnaire rating scores about the feeling of *kawaii*
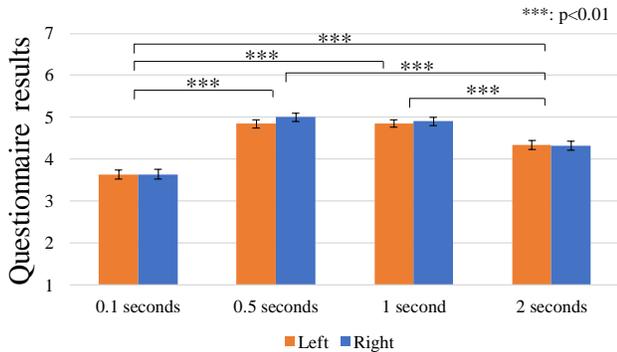
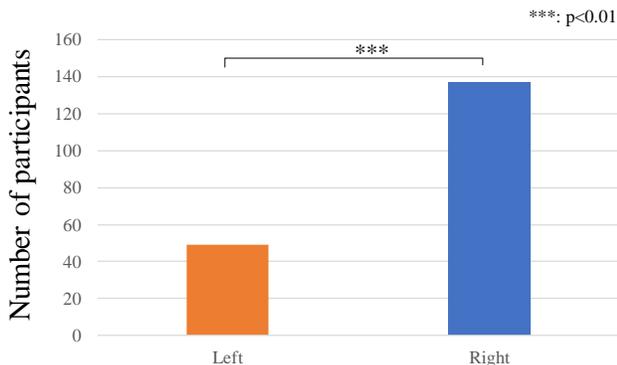Figure 3. Means and standard errors of questionnaire rating scores about the degree of wanting-to-approach

Figure 4. Number of preferred directions for robot's head-tilting

F. Free-description analysis

We collected 178 sentences from the free-description forms. A coder categorized them into four categories: hand gestures, head gestures, others (e.g., "dancing"), and impossible gestures (e.g., "changing facial expressions"). 104 comments suggested adding hand gestures, although most (87/104) just offered such pointless recommendations as "adding a hand (or arm) gesture" or "raising a hand." 17/104 responses provided a specific gesture like "putting its hands on its cheeks." In the head gesture category, 26 comments suggested additional head movements, including nodding and bowing. In the other category, three comments suggested dancing, two suggested a darting movement, one proposed changing the eye color, and another suggested speaking. The impossible gesture category contained 41 suggestions, none of which are feasible for our robot, such as attaching animalistic tails/ears and wiggling these new appendages.

G. Discussion

Our experimental results offer several practical implications. First, our analysis of the speed effects demonstrated that an appropriate range of motion speed, i.e., 0.5 seconds to 1 second, is crucial for enhancing feelings of *kawaii*. Although this study was conducted using only one robot, it provided novel insight into motion speed in head-tilting, especially since a past investigation of the effects of head-tilting motions only used static images [13].

Second, our analysis of the preferences of the head-tilting-motion direction identified the advantage of a right-direction head-tilting motion from the observer's perspectives. Note that the analysis of the feelings of *kawaii* and the degree of wanting-to-approach did not show significant differences between left and right directions, although the analysis of the preferences clearly did find differences between them. A previous study also reported no significant differences between directions in the context of the perception of cuteness [13]. However, one work did identify a difference concerning trustworthiness and attractiveness contexts [5]; a left head-tilt from the observers' perspectives was deemed more trustworthy than a right head-tilt, although attractiveness showed the opposite phenomenon. Our experiment results provide new evidence to support the advantages of a right-direction head-tilting motion in the context of preferences.

The participants offered several suggestions on their free-description forms and possible additional behaviors. Most vaguely suggested the effectiveness of hand gestures, and some noted a specific behavior, i.e., putting hands on cheeks (hands-on-cheeks). Therefore, we employed this hand gesture and investigated whether it increases feelings of *kawaii* using the optimal motion speed for head-tilting motion and its direction, as determined by the results of Experiment I.

III. EXPERIMENT II

Our second experiment investigated the effects of hands-on-cheeks gestures, which accompanied head-tilting toward *kawaii* feeling, designed based on the free-description forms gathered from the first experiment.

A. Visual stimuli and conditions

We used 5-second videos in which the robot placed its hand(s) on its cheek(s) during head-tilting motions with a fixed direction and motion speed. We made four videos, each of which again featured *Sota* making one of the following motions: placing its left hand on its left cheek, placing its right hand on its right cheek, placing both hands on both cheeks, or no hand gesture. Note that since the free-description forms in Experiment I did not specify which hand should make this additional gesture, we prepared all three combinations (left, right, and both). Based on the results of Experiment I, we followed a previous work [13] and set the tilt angle to about 20 degrees, the head motion's speed to 0.5 seconds, and the tilting direction to the right from the observer's perspective. The resolution of each video was 1920×1080 pixels. Their frame rates were 30 per second Fig. 5 shows screenshots of each condition.

B. Measurements

As in Experiment I, we employed two questionnaire items to investigate the strength of their experiences of *kawaii*: the feeling of *kawaii* and the degree of wanting-to-approach. The items were assessed on a 1-to-7 response format, where 1 denoted *not kawaii at all* and 7 denoted *extremely kawaii*.

Figure 5.   Snapshots of videos (no, left, right, and both): Timing of starting hands-on-cheeks behavior is identical as head-tilting.
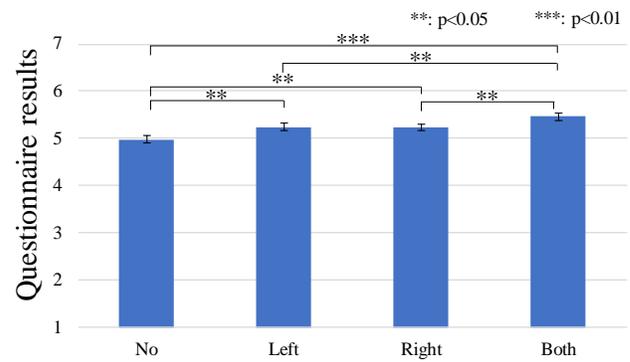

Figure 6.   Means and standard errors of questionnaire rating scores about the feeling of *kawaii*
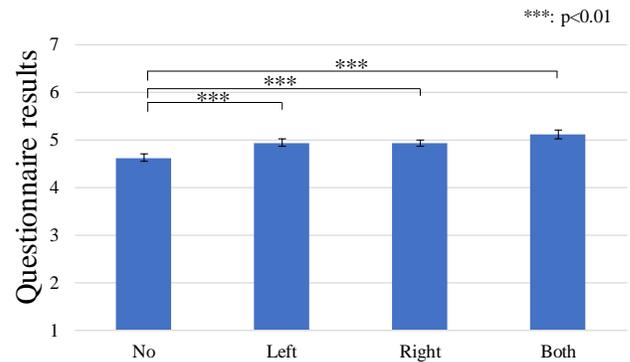
Figure 7.   Means and standard errors of questionnaire rating scores about the degree of wanting-to-approach

C. Procedure

Experiment II's procedure is essentially identical to Experiment I. The Advanced Telecommunication Research Review Boards (21-501-3) approved our experiment procedures. The participants read explanations about the experiment and how to evaluate each video. They then watched all four videos in different orders and filled out the questionnaires. The experiment was a within-participant design, and then participants watched four videos and evaluated them. The order of the videos was counterbalanced to minimize order effects. Finally, we prepared the same three dummy items from Experiment I using an example instruction manipulation check and removed participants who answered them.

D. Participants

This experiment was again conducted using the participant pools of a Japanese survey company. 215 people participated: 108 women, 103 men, and 4 who declined to specify. (We excluded the participants of Experiment I from the recruiting process.) Their average age was 42.84. The screening process narrowed that number to 193 valid participants: 95 women, 94 men and four who declined to specify. Their average age was 42.56.

E. Questionnaire results

We conducted a one-factor repeated-measures (*motion* factor: *no, left, both, right*) ANOVA to analyze feelings of *kawaii* (Fig. 6). The results showed a significant difference in the *motion* factor ($F(3, 576) = 15.411$, $p < 0.001$, partial $\eta^2 = 0.074$). Multiple comparisons with the Bonferroni method revealed the following significant differences: between *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*, $p = 0.002$). There was no significant difference between *left* and *right* ($p = 1.000$).

We also conducted a one-factor repeated-measures (*motion* factor: *no, left, both, right*) ANOVA to analyze the degree of wanting-to-approach (Fig. 7). The results showed a significant difference in the *motion* factor ($F(3, 576) = 14.762$, $p < 0.001$, partial $\eta^2 = 0.071$). Multiple comparisons with the Bonferroni method revealed the following significant differences: between *no* and *left* (*no* < *left*, $p < 0.001$), *no* and *both* (*no* < *both*, $p < 0.001$), and *no* and *right* (*no* < *right*, $p < 0.001$). No significant difference was observed between *left* and *both* ($p = 0.094$), *left* and *right* ($p = 1.000$), or *both* and *right* ($p = 0.077$).

In summary, the feeling of *kawaii* significantly varied across different motion factors, with the *both* conditions showing higher feeling of *kawaii* than the *left* and *right* conditions. Regarding the degree of wanting-to-approach, our

analysis results also significantly varied across different motion factors, where the *left*, *both*, and *right* conditions showed higher degrees of wanting-to-approach than *no*. In addition, both hand gestures had an advantage over the left- and right-hand gestures in the context of feeling of *kawaii*, although our analysis of the degree of wanting-to-approach did not find any significant difference among them.

F. Discussion

Our experimental results spotlight several practical implications. First, the analysis of hand gestures showed that the behaviors (putting hands on cheeks) suggested by the participants in Experiment I effectively increased the feelings of *kawaii* and the degree of wanting-to-approach. Although the provided comments did not specify which hand should make the gestures, our investigation, which considered all the combinations, revealed the advantage of using both arms in the context of the feeling of *kawaii*. Why might such behavior increase the feeling of *kawaii*? Perhaps covering the face with the hands makes the former appear slimmer, and a small chin is an attractive facial feature [39, 40], as related to the baby schema [17, 18]. In this context, another past study addressed face-covering poses as a feature of cuteness in image-processing [41]. Some works in East Asian culture suggest that such gestures increase the cuteness of people [42-45]. Therefore, based on the knowledge gained from this experiment, one possible future work will investigate the effects of these gestures across different cultures.

IV. CONCLUSION

This study represents our first investigation into the effects of head-tilting motions and additional hand gestures on observer's feelings of *kawaii*. We conducted a series of two web surveys. The first experiment identified the optimal motion speeds and directions for the head-tilting motions of a social robot to increase the feeling of *kawaii*. Based on a suggestion from participants in the first experiment, the second examined the effectiveness of an additional hand gesture (hands-on-cheeks) during head-tilting motions and found that using both hands effectively increased the feeling of *kawaii*.

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