

Cross-cultural Design and Evaluation of Student Companion Robots with Varied Kawaii (Cute) Attributes

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Abstract. We report on an extension of a cross-cultural collaborative project between students and faculty at DePauw University in the United States and Shibaura Institute of Technology in Japan. The ongoing project uses cross-cultural teams to design and evaluate virtual companion robots for university students with the goal of gaining a deeper understanding of the role that kawaii (Japanese cuteness) plays in fostering positive human response to, and acceptance of, robots across cultures. Members of two cross-cultural teams designed virtual companion robots with specific kawaii attributes. Using these robots, we conducted the first phase of a two-phase user study to understand perceptions of these companion robots. The findings demonstrate that participants judge round companion robots to be more kawaii than angular ones and they also judge colorful robots to be more kawaii than greyscale robots. The phase one study identified pairs of robots that are the most appropriate candidates for conducting further investigations. The appropriateness of these pairs holds across male and female participants as well as across participants whose primary culture is American and those whose primary culture is Japanese. This work prepares us to perform a more detailed study across genders and cultures using both survey results and biosensors. In turn, this will inform our long-term goal of designing robots that are appealing across gender and culture.

Keywords: Kawaii, Human-Robot Interaction, Cross-cultural Design.

1 Introduction and Motivation

1.1 Kawaii

As robots become increasingly common in daily life, it is critical that roboticists design devices that are accepted broadly, including across cultures and genders. Toward this end, global collaboration is pivotal today and in the future. This paper reports on the second year of a three-year cross-cultural collaboration between students and faculty at DePauw University in the United States and Shibaura Institute of Technology in Japan. We formed two cross-cultural teams to design and evaluate virtual companion robots to gain a deeper understanding of the role that kawaii (Japanese cuteness) plays in fostering positive human response to, and acceptance of, these devices across cultures.

As we have previously reported in [1], the word, *kawaii*, is often translated into “cute,” “lovely,” “adorable,” “cool,” and sometimes other words depending on the context. There does not seem to be an exact word that can be used as a counterpart in English [2]. That’s probably because Japanese people’s affection for “kawaii” has been cultivated throughout Japanese history [3]. The sentiment of kawaii seems to have been present in Japanese society since 400 B.C., and the word itself started appearing around the 11th century in literary texts [4, 5]. The meaning of the word has evolved to become a cultural concept or an emotional domain that relates to something or someone lovely, or someone or something that invokes the feeling of “wanting to protect” [5]. In the modern context, the notion of kawaii is embraced as a catalyst to evoke positive feelings [6], as can be seen in designs ranging from Hello Kitty products to road signs to robotic gadgets, to name just a few examples. Kawaii has also been gaining global audiences and customers in the last two decades as well as in Japan [6] through kawaii products. Kawaii design principles are now incorporated into successful products that are used globally including in robotic gadgets [8, 9].

1.2 Prior Work

As we have summarized in [1] previous studies have examined cross-cultural differences in the acceptance of robots based on various design characteristics. For example, researchers have documented the impact of localizing a robot’s greeting style (gestures and language) on acceptance by Japanese versus Egyptian users [10].

Similarly, prior studies have examined perceptions of kawaii, including differences in perceptions across cultures and genders. These studies have found gender differences in preferences for various kawaii spoon designs based on shape, color and geometric pattern [11]. A broader study examined the extent to which perceptions of kawaii in 225 photographs differ between male and female Japanese college students [12]. In this study, gender differences were established, depending on the type of object photographed. For example, male subjects found spherical geometric objects to be more kawaii than female subjects [12]. The first two authors extended the original study by presenting 217 of the original 225 images to American college students and gathering data about their perceptions of kawaii-ness in each image. For some types of objects, differences in perceptions of kawaii-ness were found, particularly between Japanese

males and American males as well as between Japanese females and all other groups [13].

Prior work that investigates the role of kawaii in user perceptions and user acceptance of robots or robotic gadgets is limited. However, one pair of papers reports on studies of kawaii-ness in the motion of robotic vacuum cleaners [14, 15]. The authors programmed a visually plain version of a Roomba vacuum cleaner to move according to 24 different patterns, including patterns that the authors describe with terms such as: bounce, spiral, attack, spin and dizzy [14, 15]. The studies demonstrated that kawaii-ness can be expressed through motion, even in the absence of more traditional visual kawaii-ness; however, the studies did not consider cultural or gender differences.

In addition, prior work done by the first six authors and their collaborators suggests that designing a robot to be more animal-like, rounder, shorter, and smaller increases participant’s perceptions that the robot is kawaii/cute [1]. This work also suggests that designing a robot to be more kawaii/cute appears to positively influence human preference for being around the robot. These findings held across Japanese and American culture and across males and females [1]. In this work, both males and females preferred smaller robots to larger ones; however, this preference was more significant for females. However, no other differences were found between genders or between cultures. [1]. The current paper builds on the previous work in that we now focus on the design and evaluation of companion robots for university students and we demonstrate that the effect of specific kawaii attributes holds across multiple robot designs.

2 Design of Companion Robots for University Students

2.1 Overview

In recent years, concerns about anxiety and other mental health issues in university students have been widely reported in the media in both the United States and in Japan. Both the American and Japanese governments also extensively address the issues [16, 17]. At some universities, increased student anxiety has led to a greater number of students requesting to bring emotional support animals to campus [18]. For example, Washington State University fielded only a handful of requests for emotional support animals annually as of 2011 but by 2019 was fielding 60 – 75 requests per year [18].

As early as 2003, Fogg proposed what he then considered to be a futuristic “study buddy” that would assist students by prompting them to adopt good living and study habits and by providing other helpful information [19]. What seemed like a futuristic way to assist students in 2003 is now more realistic. For example, several schools have experimented with providing all students with Amazon Echo Dots that use Alexa to equip every student room with a student assistant service, customized with campus-specific information [20]. While this use of Echo Dots may support students by providing an information assistant, the approach does not provide the same type of comfort as a companion animal.

Robotic versions of companion animals have been used in hospitals, nursing homes and other extended care facilities to comfort dementia patients as well as other older

adults [21]. Perhaps the best known of these is PARO, a therapeutic robot that originated in Japan, and has been in use since 2003 [22]. PARO is designed as a soft robot that resembles a small, white, baby seal. PARO “blinks and coos when petted [and] is often therapeutic for patients with dementia” [23]. PARO is particularly attractive for use in hospitals and nursing homes because logistical constraints make it difficult to take care of real pets in these facilities.

This paper reports on continued work, supported by a United States National Science Foundation (NSF) International Research Experiences for Undergraduates (IRES) grant, to gain a deeper understanding of the role that *kawaii* plays in fostering positive human response to, and acceptance of, robotic gadgets across cultures. More information about the goals of this grant-supported project may be found in [24, 25]. We focused our work in summer of 2021 on the design and evaluation of virtual companion robots for university students due to the potential of such robots to address the real world problems described above.

With mentorship from faculty members at Shibaura Institute of Technology and DePauw University, two cross-cultural student design teams conceptualized personas and scenarios that they then used to guide their work in using Unity to design and implement prototypes of virtual companion robots.

Each design team was comprised of four students -- two students from Shibaura Institute of Technology in Japan and two students from DePauw University in the United States.

2.2 Team One’s Persona, Scenario and Companion Robot Designs

The first student team developed a persona (composite user to design for) and a scenario to guide their work. The persona was given a gender-neutral name and the scenario was written to make sense in both an American and Japanese cultural context. The persona and scenario were written in English and then translated into Japanese in preparation for the cross-cultural user-study that is described later in this paper. The English version of the persona and scenario is presented below.

Team One Persona: Terry is a 19-year-old first-year university student who is not completely familiar with their campus. Terry frequently gets lost on campus and is late. Terry is nervous about being on time for class and remembering all of their responsibilities. Terry needs help remembering where things are and when Terry needs to do things, such as taking medication, eating properly, and getting enough sleep.

Team One Scenario: One morning, the robot realizes Terry is not awake 30 minutes before their class, so the robot says “Terry it is time to get up, you don’t want to be late!” to wake Terry up. When Terry gets up the robot spins, dances and claps. After that, the robot checks Terry’s schedule and says, “Good Morning, your first class is at 8:00 AM.”, you have 10 minutes to get ready”. The robot brings Terry their medication and breakfast. The robot says “Let’s go to class!” and encourages Terry to follow it by carrying Terry’s backpack. The robot then takes Terry to their class, and upon arrival spins and claps. This makes Terry feel happy”.

After collaborating to develop the persona and scenario, each team member designed four versions of a virtual companion robot that demonstrated the part of the scenario

where the robot wakes Terry up by moving around and saying “Terry, it is time to get up, you don’t want to be late.”

Using the persona and scenario as a guide, each team member developed a round, colorful, and animal-like companion robot that enacted the selected portion of the scenario. This version of the robot is expected to be judged to be kawaii because roundness, colors (especially bright saturated colors of various hues including yellow and purple) and animal-like faces are attributes that have been associated with kawaii-ness in previous studies [1, 26]. We refer to this version of the companion robot as round-colorful (RC). The student researcher then created a second robot by changing the color to greyscale resulting in a version that we refer to as round-greyscale (RG). Next, the student researcher developed a version that was angular and colorful without animal-like features resulting in a companion robot that we refer to as angular-colorful (AC). Finally, color was replaced with greyscale to produce a version that we refer to as angular-greyscale (AG). Tables 1 through 4 show the four companion robot versions developed by each of the student researchers on team one. In each table, the upper-left corner shows the round-colorful (RC) version, the upper-right corner shows the round-greyscale version (RG), the lower-left corner shows the angular-colorful version (AC) and the lower-right corner shows the angular-greyscale version (AG).

Table 1. Four Companion Robots Developed by a member of Team One

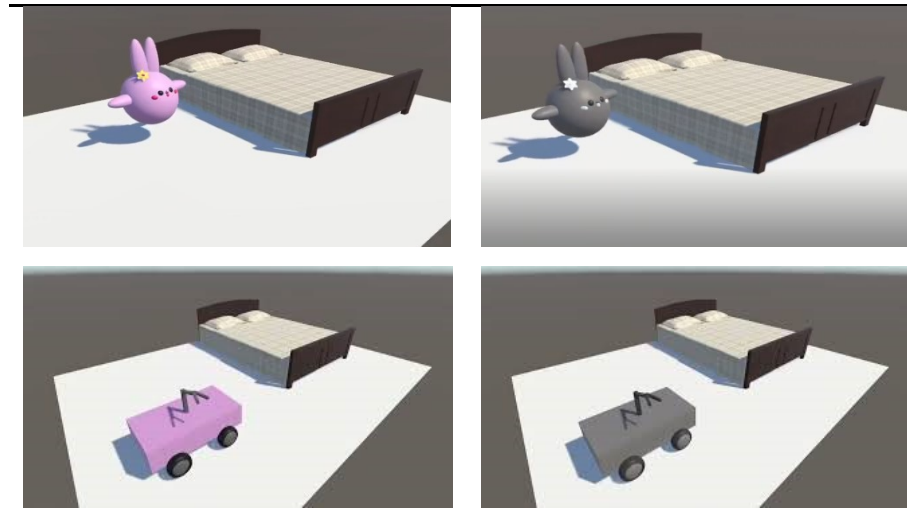


Table 2. Four Companion Robots Developed by another member of Team One

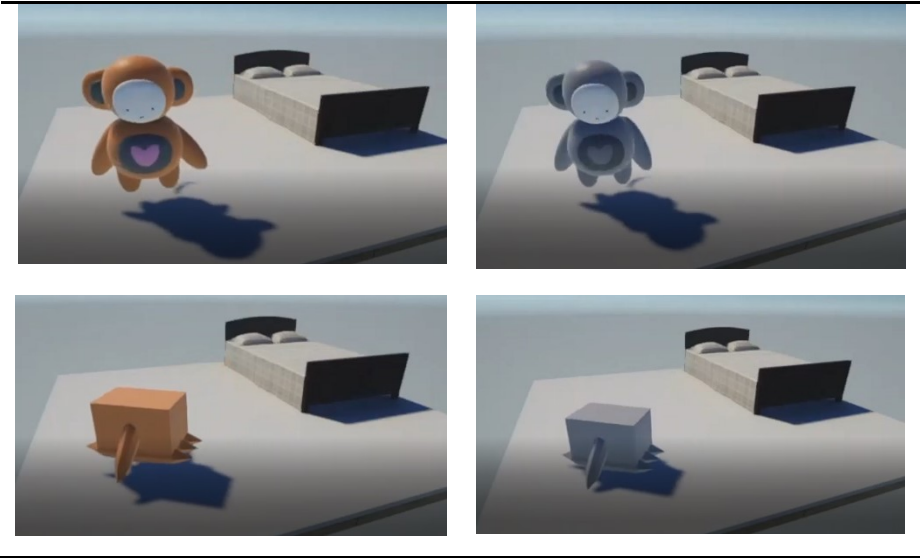


Table 3. Four Companion Robots Developed by a member of Team One

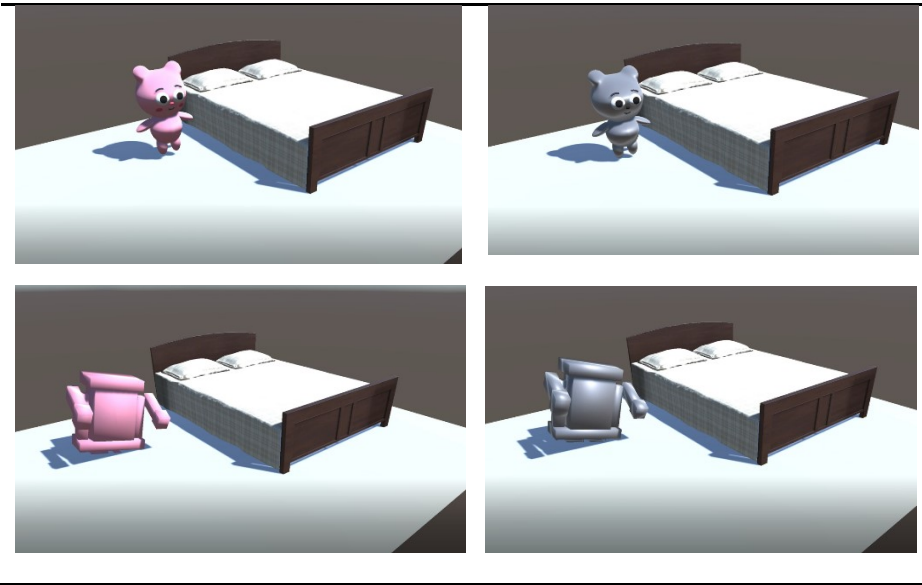
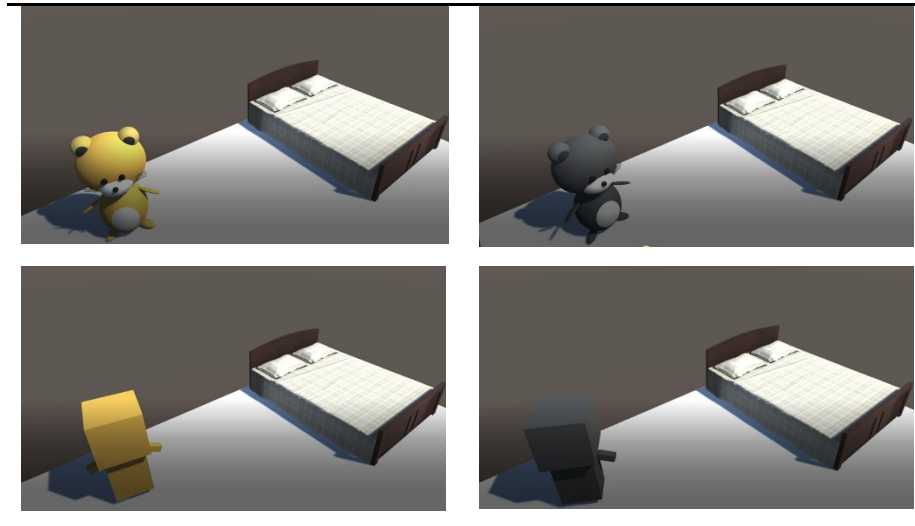


Table 4. Four Companion Robots Developed by another member of Team One

2.3 Team Two's Persona, Scenario and Companion Robot Designs

The second student team also developed a persona and a scenario to guide their work. Like team one, their persona was given a gender-neutral name and their scenario was designed to make sense in both an American and Japanese cultural context. The persona and scenario were written in English and then translated into Japanese in preparation for the cross-cultural user-study that is described later in this paper. The English versions of the persona and scenario are presented below.

Team Two Persona: Sam is a 19-year old university student, who has become overwhelmed by their schoolwork and obligations. This has led them to lose sleep, miss meals, and consistently forget assignments.

Team Two Scenario: In the evening, Sam's robot does a calendar check and realizes that Sam has an assignment to complete tonight. Sam's robot stands up and says to Sam "You need to do your assignments." The robot then bends its head in a sad manner until Sam starts working. When Sam finishes their assignment, the robot does a dance, and says "Congratulations on your hard work, Sam. Enjoy the rest of your evening." This makes Sam feel happy and content with their work.

Each team member designed four versions of a virtual companion robot that demonstrated the part of the scenario where the robot congratulates Sam on completing an assignment by dancing and saying "Congratulations on your hard work, Sam. Enjoy the rest of your evening."

Using the persona and scenario as a guide, each team member developed a round and colorful companion robot (RC), as well as a round-greyscale version (RG), an angular-colorful version (AC) and an angular-greyscale version (AG). Tables 5 through 8 show the four companion robot versions developed by each of the student researchers

on team two. In each table, the upper- left corner shows the round-colorful (RC) version, the upper-right corner shows the round-greyscale version (RG), the lower left corner shows the angular-colorful version (AC) and the lower-right corner shows the angular-greyscale version (AG).

Table 5. Four Companion Robots Developed by a member of Team One

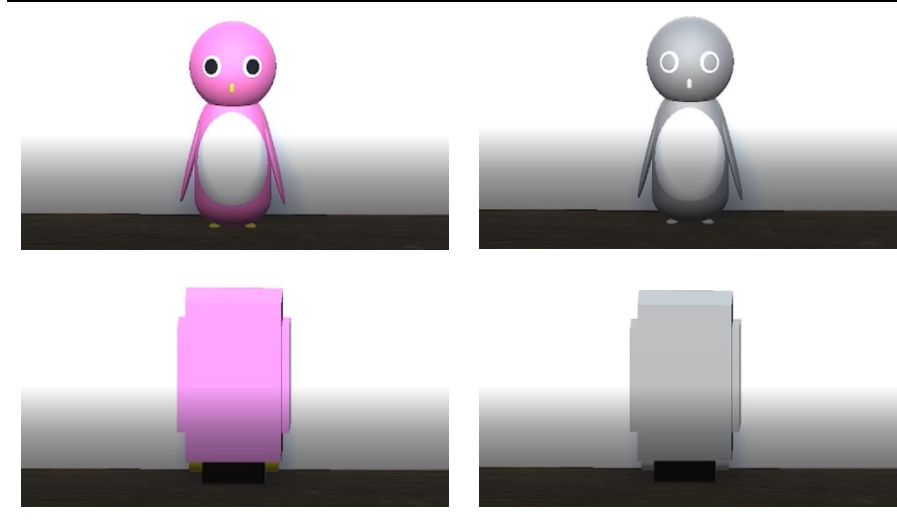


Table 6. Four Companion Robots Developed by a member of Team One

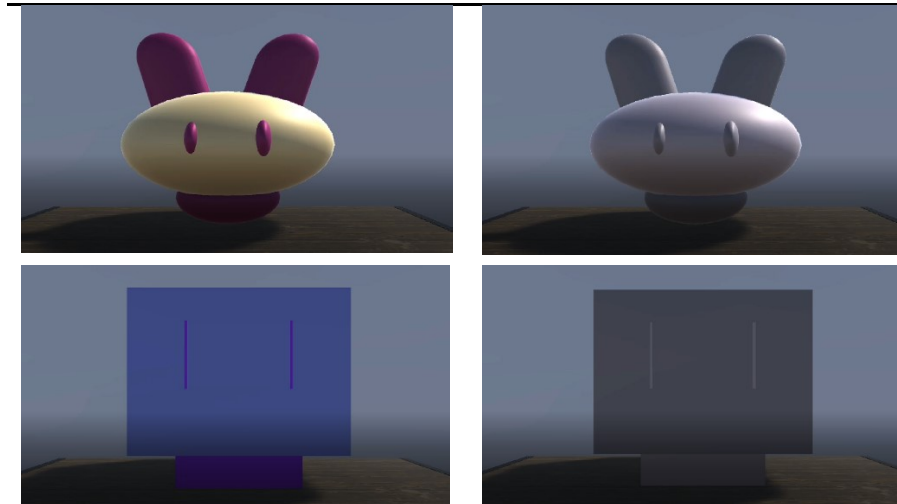
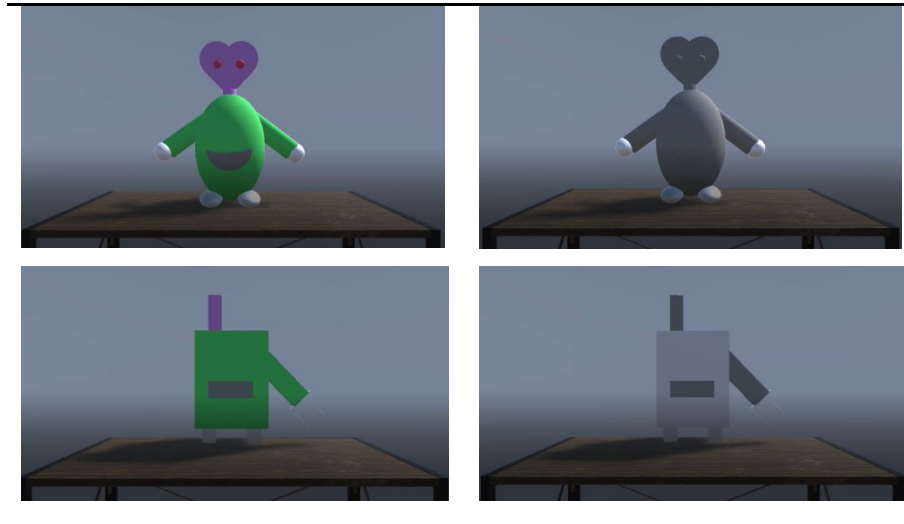
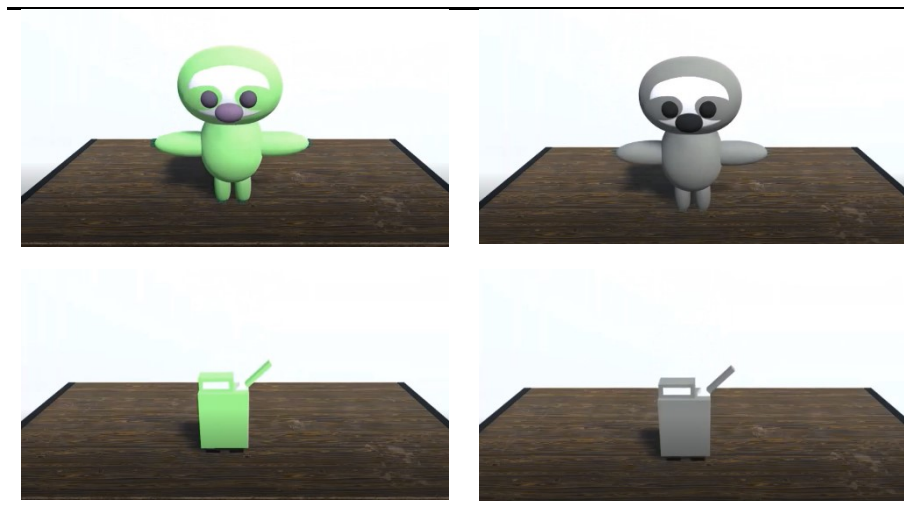


Table 7. Four Companion Robots Developed by a member of Team One**Table 8.** Four Companion Robots Developed by a member of Team One

3 Evaluation

3.1 Purpose of the Evaluation

We plan a two-phase evaluation of the eight sets of virtual robots that are described in the previous section. Taken together, the two-phase evaluation employs the following measures, each of which can be examined across gender and across culture (American versus Japanese):

- **Reported Kawaii/Cuteness:** For a given prototype, what is the participant’s self-reported perception of the prototype’s cuteness/kawaii-ness?
- **Measured Joy:** For a given prototype, what impact does the prototype have on participant’s joy as measured by biosensors that track heartrate and brainwaves?
- **Reported Acceptance:** for a given prototype, to what degree does the participant believe the prototype is likely to be accepted for its intended purpose?

The phase one evaluation reported in this paper focuses on the first measure. In addition to exploring the first measure in more detail, the phase two evaluation will also consider the remaining two measures and will explore correlations between pairs of measures. For example, we hypothesize that self-reported Kawaii/Cuteness will positively correlate with Measured Internal Joy across prototypes. We also hypothesize that Measured Internal Joy will positively correlate with Self-Reported Acceptance across prototypes.

The design process described in section 2 resulted in 32 different robot companion prototypes. It is difficult to carry out a study in which participants engage meaningfully with 32 different prototypes. This is especially true if the study involves taking measurements with biosensors, such as those that measure EEG, which require participants to wear a carefully positioned headset.

Phase one of the evaluation, which is described in the rest of this section, identifies robots for the first scenario that have the greatest variation in Reported Kawaii/Cuteness between the cutest robots and the least cute robots. This phase of the evaluation also identifies a parallel set of robots for the second scenario.

The identified robot sets will be used in phase two of the evaluation, which will be reported on in a future paper. Phase two of the study will gather more data from participants, including biosensor data, and qualitative data about their reaction to the selected robots.

For phase one of the evaluation, we designed and administered an online survey to measure perceptions of the 32 robot prototypes. As noted above, the survey, which was administered to Japanese and American males and females, was designed to help us select the robots to use in phase two of the study.

3.2 Participant Demographics

After obtaining Institutional Review Board approval for the study, we recruited participants whose primary culture was American as well as participants whose primary culture was Japanese. Participants had to be at least 18 years old and at most 28 years old.

In addition, participants had to have lived in the United States for at least 15 years or had to have lived in Japan for at least 15 years. In effect, this limited participation to participants who had either an American or Japanese dominant culture. Participants were also required to use a laptop or tablet to complete the survey. We did not allow participants to complete the survey on a phone because the participants watched videos of the companion robots during the study and we wanted the videos to be a reasonable size.

In total, 63 participants completed the survey. The participants ranged in age from 18 to 28 with a mean age of 20.9. All of the participants were enrolled in a university or were recent university graduates. The participants included 27 participants in the Japan-culture group (16 females and 11 males) and 36 participants in the American-culture group (15 females and 21 males). In total, then, 31 females and 32 males participated in phase one of the study. Since the primary purpose of the phase one study is to select the best candidate companion robots for a more robust phase two study, we accepted the greater number of Japanese-culture females as compared to males as well as the greater number of American-culture males as compared to females.

3.3 Study Procedure

The survey instrument was originally developed in English and then translated to Japanese by the second author. We used the adjective “cute” for the English counterpart of “kawaii” because it is one of the closest translations, although the interchangeableness has been argued [2]. The English version of the survey was administered to the American-culture participants and the Japanese version was administered to the Japanese-culture participants. Each version was administered as a Google form that embedded videos of the robots shown in Tables 1 through 8.

After accepting the conditions of an online informed consent, and confirming eligibility to participate in the survey, participants provided their age, gender and education level. Participants then watched a sample video and confirmed that they could see the video and hear the associated audio.

Participants then read the description of Terry’s persona (see section 2.2) and read the following statement of context, which is an abbreviated version of the scenario developed by the first student team (see section 2.2): “The robots shown in the following videos are designed to help Terry with tasks such as waking up on time, leading the way to campus buildings and remembering to take medication on time. You will not see Terry in the video but you will see the robot trying to wake Terry up.”

Participants then watched four videos, each 20-seconds long, showing the four companion robots developed by one of the student researchers. The first video was round and colorful (RC), the second was round and greyscale (RG), the third was angular and colorful (AC) and the fourth was angular and greyscale (AG). These companion robots are shown in Table 1. After watching each video, participants answered the following three questions:

1. “How cute is the robot?” This question was answered on a 7-point rating scale with 1 indicating “not at all cute” and 7 indicating “very cute”.

2. “How trustworthy is the robot?” This question was answered on a 7-point rating scale with 1 indicating “not at all trustworthy” and 7 indicating “very trustworthy”.
3. “How likely is it that Terry would want to use this robot?” This question was answered on a 7-point rating scale with 1 indicating “not at all likely” and 7 indicating “very likely”.

Participants then watched the four videos developed by a second student researcher who worked on this scenario (see Table 2) and participants answered the same survey questions. To counterbalance the survey, these videos were presented in the order RG, AC, AG, RC. Participants then answered the same questions about the videos that were developed by the third student researcher who worked on this scenario (see Table 3). These videos were presented in the order AC, AG, RC, RG. Finally, participants watched the set of videos developed by the fourth student researcher who worked on this scenario (see Table 4). This set of videos and questions were presented in the order AG, RC, RG, AC.

Participants then read a description of Sam’s persona (see section 2.3) and then read the following statement of context, which is an abbreviated version of the scenario developed by the second student team (see section 2.3): “The robots shown in the following videos are designed to help Sam eat regularly, turn in assignments on time and generally feel less stress. You will not see Sam in the video but you will see the robot congratulating Sam after their assignment has been completed.”

Participants then watched four sets of videos, with four videos in each set, and answered questions about each video. These companion robots are shown in Table 5, Table 6, Table 7 and Table 8. The questions used and the counterbalanced order of videos was the same as described in detail for the companion robots associated with the first scenario.

Participants were then debriefed and completed a payment form that allowed us to compensate them with an Amazon.com gift certificate in the amount of \$10 or ¥1000.

3.4 Comparison of Kawaii/Cute within each Cluster of Videos

The clustered bar chart shown in Fig. 1 provides the average Kawaii/Cute rating across all subjects for each of the eight companion robot clusters. Each four-bar cluster represents the ratings provided for the four robots designed by a single student researcher. The left-most four clusters correspond to the persona (Terry) and scenario that the first group of student researchers worked on. The right-most four clusters correspond to the persona (Sam) and scenario that the second group of student researchers worked on.

For each cluster, the left most bar corresponds to the round-colorful (RC) companion robot, the second bar from the left corresponds to the round-greyscale companion robot (RG), the second bar from the right corresponds to the angular-colorful robot (AC) and the right-most bar corresponds to the angular-greyscale robot (AG).

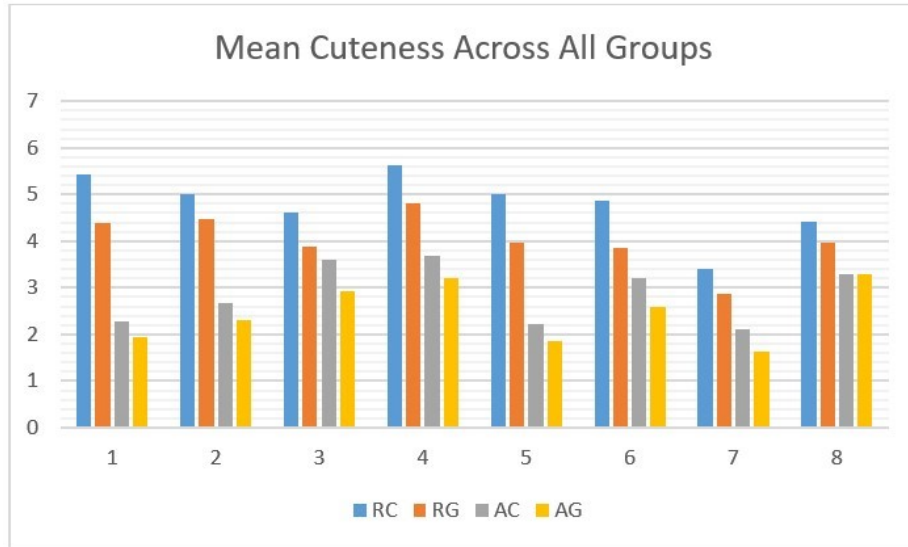


Fig. 1. Mean Cuteness Ratings Across All Groups

The horizontal access labels correspond to Tables 1 through 8 in the previous section of this paper. For example, the left-most cluster of four bars is labeled 1 and corresponds to the four robots shown in Table 1. The right-most cluster of four bars is labeled 8 and corresponds to the four robots shown in Table 8. The vertical access gives the mean cuteness score for each robot.

Within each cluster, a comparison between the RC and RG bar, as well as between the AC and AG bar represents a change based on color versus greyscale. Similarly, a comparison of the between the RC and AC bar, as well as between the RG and AG bar represents a change based on round versus angular.

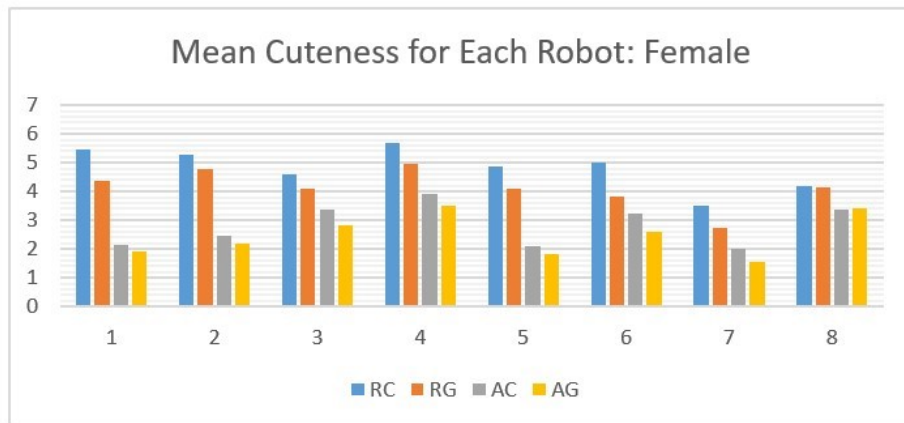
Visual inspection of the Fig. 1 suggests that within each cluster there is a tendency for round robots to be judged as more kawaii/cute than angular robots. Similarly, within each cluster, colorful robots are judged to be more kawaii/cute than greyscale robots.

Detailed means cuteness values are provided in the Table 9 below.

Table 9. Mean Cuteness/Kawaii score for each robot.

Team 1 Cluster	Mean	Team 2 Cluster	Mean
1RC	5.43	5RC	5.02
1RG	4.38	5RG	3.95
1AC	2.29	5AC	2.22
1AG	1.95	5AG	1.86
2RC	5.02	6RC	4.87
2RG	4.48	6RG	3.84
2AC	2.68	6AC	3.21
2AG	2.32	6AG	2.59
3RC	4.62	7RC	3.40
3RG	3.89	7RG	2.86
3AC	3.59	7AC	2.11
3AG	2.94	7AG	1.63
4RC	5.63	8RC	4.43
4RG	4.81	8RG	3.97
4AC	3.70	8AC	3.30
4AG	3.21	8AG	3.30

The bar-graph shown in Fig. 1 and the data shown in Table 9 present mean cuteness scores across all subjects (female, male, Japanese-culture, American-culture). We also examined the means for gender and culture separately to investigate whether or not they are consistent with the overall results. The results are shown in Fig. 2 through Fig. 4 below.

**Fig. 2.** Mean Cuteness Ratings by Females

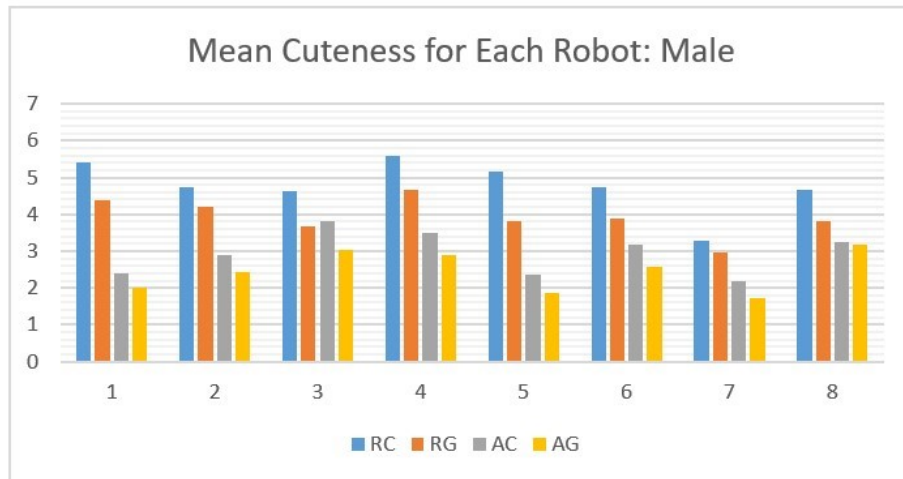


Fig. 3. Mean Cuteness Ratings by Males

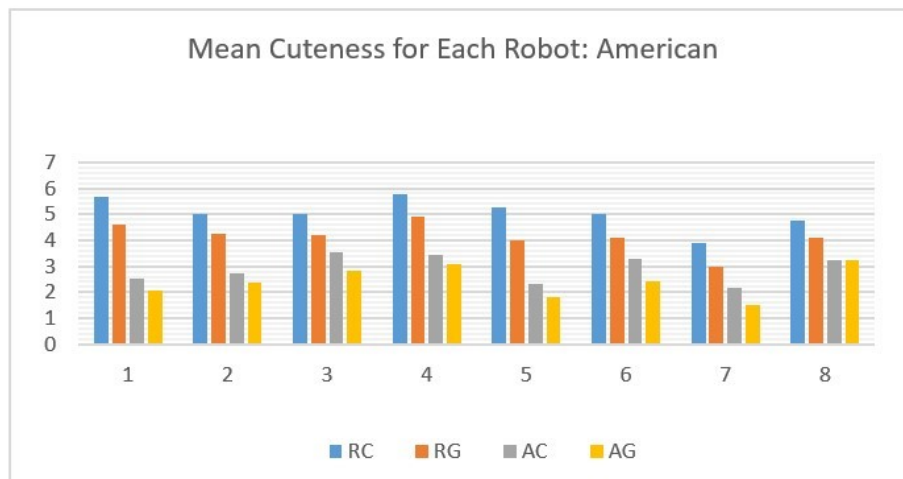


Fig. 4. Mean Cuteness Ratings by American-culture Participants

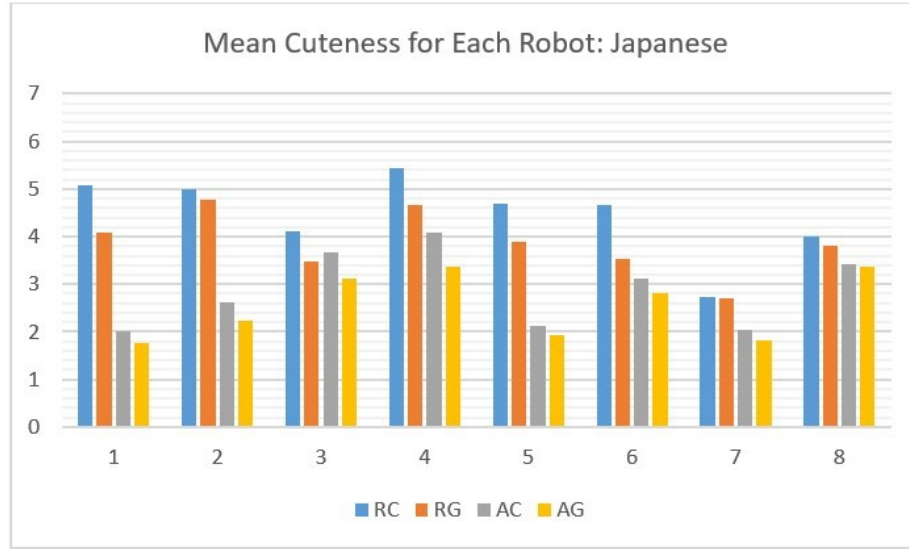


Fig. 5. Mean Cuteness Ratings by Japanese-culture Participants

3.5 Differences between Round-Colorful and Angular-Greyscale Robots

Visual inspection suggests that the tendencies are strikingly similar regardless of gender or cultural background. For each cluster, the round-colorful (RC) robot is judged to be the most kawaii/cute and the angular-greyscale (AG) robot is judged to be the least kawaii/cute. In addition, the participants' perception of kawaii-ness/cuteness has similar tendencies within each set of robots across gender and culture. A one-way ANOVA was performed to compare the effect of four different robots on rating scores within each cluster. These ANOVAs revealed that there were statistically significant differences in mean rating among the four robots in each cluster.

- Cluster 1 $F(3, 248) = [108.91]$, $p < 0.001$
- Cluster 2 $F(3, 248) = [54.32]$, $p < 0.001$
- Cluster 3 $F(3, 248) = [9.74]$, $p < 0.001$
- Cluster 4 $F(3, 248) = [33.31]$, $p < 0.001$
- Cluster 5 $F(3, 248) = [70.16]$, $p < 0.001$
- Cluster 6 $F(3, 248) = [22.71]$, $p < 0.001$
- Cluster 7 $F(3, 248) = [20.57]$, $p < 0.001$
- Cluster 8 $F(3, 248) = [5.56]$, $p = 0.0010$

These results demonstrate the effect of the various levels of the kawaii/cute attributes (roundness and color) that were introduced into the robots in each cluster.

3.6 Selecting sample robots for the second-phase biosensor study

As explained earlier, this study represents the first phase of the two-phase study. Our goal in this phase is to select robots we can use for a more in depth analysis in phase two of our work, where we will use additional survey questions, biosensors and qualitative measure to better understand participant's reactions to, and acceptance of, robots based on their level of cuteness. Specifically, our goal in phase one is to select two robots that were widely perceived as kawaii/cute and two robots that were widely perceived not to be cute among the 16 robots that the first team created. Similarly, we want to select two robots that were widely perceived as kawaii/cute and two robots that were widely perceived not to be cute/kawaii among the 16 robots that the second team created. These eight robots, four from team one and four from team two, will be used in phase two of our study.

We selected the two robots that received highest cute/kawaii ratings for team one. The selected robots are 1RC (mean = 5.43) and 4RC (mean = 5.63). A repeated measures t-test was performed to compare these robots. The t-test did not reveal statistically significant difference ($t_{(62)} = -1.12$, $p > 0.05$). Thus, we conclude that these two robots are similarly good candidates to serve as examples of cute/kawaii robots for team one in the phase-two study.

Similarly, we selected the two robots that received highest cute/kawaii ratings for team two. The selected robots are 5RC (mean = 5.02) and 6RC (mean = 4.83). A repeated measures t-test was performed to compare these robots. The t-test did not reveal statistically significant difference ($t_{(62)} = 0.61$, $p > 0.05$). Thus, we conclude that these two robots are similarly good candidates to serve as examples of cute/kawaii robots for team two in the phase-two study.

We also selected the two robots that received the lowest mean cute/kawaii ratings from team one. The selected robots were 1AG (mean = 1.95) and 2AG (mean = 2.32). A repeated measures t-test was performed to investigate the difference between these robots. The result did not reveal statistically significant difference between these two robots ($t_{(62)} = -1.98$, $p > 0.05$). Thus, we conclude that these two robots are similarly good candidates to serve as examples of the least cute/kawaii robots for team one in the phase-two study.

Similarly, we selected the two robots that received the lowest mean cute/kawaii ratings for team two. The selected robots were 5AG (mean = 1.86) and 7AG (mean = 1.63). A repeated measures t-test was performed to investigate the difference between these robots. The result did not reveal a statistically significant difference between these two robots ($t_{(62)} = 1.81$, $p > 0.05$). Thus, we conclude that these two robots are similarly good candidates to serve as examples of the least cute/kawaii robots for team two in the phase-two study.

The highly cute/kawaii robots we selected for team one are found in the upper-left corner of Table 1 and Table 4. Both robots were round and colorful. The least cute/kawaii robots we selected for team one are found in the lower-right corner of Table 1 and Table 2. Both robots were angular and greyscale.

Similarly, the highly cute/kawaii robots we selected for team two are found in the upper-left corner of Table 5 and Table 6. Again, both robots were round and colorful.

The least cute/kawaii robots we selected for team two are found in the lower-right corner of Table 5 and Table 7. Both robots were angular and greyscale.

4 Discussion

The four robots in each cluster were designed with specific combinations of attributes to make them appear cute or not cute based on previous research. The results were consistent with previous findings: the use of color and roundness (including animal features) seem to contribute to participants' perception of cuteness/kawaii-ness.

Visual inspection of the bar graphs in Fig 1. through Fig. 5 show that the effects tend to be cumulative in that round robots tend to be judged to be more cute/kawaii than angular ones, and colorful robots tend to be judged to be more cuter/kawaii than greyscale robots. However, robots that are round and colorful tend to be judged as more cute/kawaii than robots that are only round or only colorful.

Importantly, the tendency for round, colorful robots to be judged to be cuter than angular, greyscale robots holds across all eight robot clusters even though each cluster was developed by a different student researcher and the videos showing the robots in four of the clusters were shown to participants in the context of one scenario while the videos of the robots in the other four clusters were shown to the participants in the context of a different scenario. These tendencies also hold across females, males, Japanese-culture individuals and American-culture individuals. Thus, the results imply general principles about perceptions of cute/kawaii rather than the being tied to specific robot designs or demographic groups.

5 Future Work

The design process described in section 2 resulted in 32 different companion robot prototypes. The evaluation described in section 3 has helped us identify a subset of robots that vary dramatically in their level of cuteness/kawaii-ness and this subset of robots will be used in some of our future work. In particular, for the eight robots we identified, we will explore the following three measures that were first presented in section 3.1:

- **Reported Kawaii/Cuteness:** For a given prototype, what is the participant's self-reported perception of the prototypes cuteness/kawaii-ness?
- **Measured Joy:** For a given prototype, what impact does the prototype have on participant's joy as measured by biosensors that track heartrate and brainwaves?
- **Reported Acceptance:** for a given prototype, to what degree does the participant believe the prototype is likely to be accepted for its intended purpose?

While we focused on the first measure in this paper, the phase two evaluation will consider the remaining two measures and will explore correlations between pairs of measures. For example, we hypothesize that self-reported Kawaii/Cuteness will positively correlate with Measured Internal Joy across prototypes. We also hypothesize that Measured Internal Joy will positively correlate with Self-Reported Acceptance

across prototypes. This could have implications for the style of companion robot that would be the most effective student assistant.

Secondly, although cultural and gender differences were not the center of this study, we are interested in investigating what the results show in terms of differences in perception due to gender and cultural background.

In addition, we plan to carry out a deeper exploration of the eight round colorful robots. As a group, these robots tended to be judged as most cute/kawaii. We will use quantitative and qualitative surveys to better understand why participants found these robots to be cute/kawaii and what differences participants perceive between these eight robots.

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