How Do We Feel When Babyloid Starts Crying Suddenly?

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Abstract. We investigated whether Babyloid, which is a robot designed to act like a human baby, induces feeling that people want to care or help it by focusing on the distance between individuals and the robot. We evaluated how people when Babyloid suddenly started crying by using three distances of personal spaces (intimate (30 cm), personal (100 cm), and social (200 cm)). As a result, participants at an intimate distance had a feeling to help Babyloid, those at a personal distance either wanted to help it or avoided it, and those at a social distance showed no such feeling.

Keywords: Human-robot interaction, personal space, Babyloid.

1 Introduction

Recently, entertainment robots, e.g., AIBO [1], PaPeRo [2], and Ifbot [3], which create a positive impression such as comfort and delight, have been developed. Another such robot is Babyloid [4,5], which is designed to act like a human baby, i.e., it is helpless. Unlike general robots, which are built to do all tasks with the same capabilities as humans, Babyloid was designed to be helpless but tries to be self-sufficient, which is the ability of animals to sustain themselves over a long term [6], by expressing its psychological and physiological condition through crying. An example of self-sufficiency in a robot may be the ability to provide itself with fuel so it can maintain its power level. Although there is a tendency to think that, intuitively, self-sufficiency is carried out by oneself as in the example above, there are many real-world instances where self-sufficiency is fulfilled by others. Examples of such self-sufficiency include methods babies use. A baby is absolutely dependent on his or her mother and fulfills self-sufficiency by using the mother as an intermediary. That is, by expressing psychological and physiological instabilities and bodily discomfort through facial expressions and bodily movements, the baby gets his or her mother to observe his or her conditions and improve them. We focus on this fact and seek to arouse the feeling of "I am taking care of someone" in users by having Babyloid entreating them to take care of its discomfort through its interactions with them.

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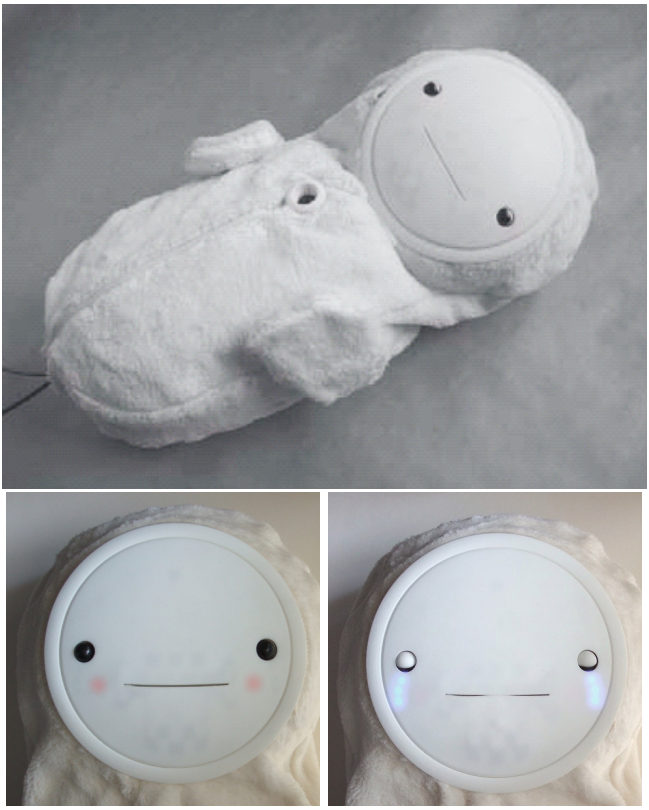

Fig. 1. Babyloid

Human babies cry when they need something from other people, especially their mothers. However, it is unclear whether Babyloid can induce people to want to care for or help it. We investigated whether Babyloid can do this by focusing on the distance between it and people. Specifically, we evaluated how people behave when Babyloid suddenly starts to cry by changing the distance between them and the robot. We used three personal space distances (intimate (30 cm), personal (100 cm), and social (200 cm)) [7].

2 Babyloid

Figure 1 shows photographs of Babyloid, which is 44 cm long and weighs 2.2 kg. It was critical to make it obvious that the robot is helpless. Thus, it has no feet to indicate that it cannot walk, and its arms are short to indicate that it cannot perform actions like rolling over.

Babyloid's voice was created by sampling the voices of human babies of about one year of age. Human babies of this age often still cannot talk, but their

utterances may sound like actual words. By using such a voice, we can elicit diverse interpretations from people and induce psychological interactions. Also, babies at this age imitate words spoken by people around them and repeat these imitations. Because Babyloid can recognize single words, we designed it so that it can respond by a mimicking a voice when it recognizes words it is capable of repeating.

The face is made of 1.5-mm-thick silicon resin, which is stretched using motors in the mouth and jaw region to create expressions. The eyes open and close through motors. Babyloid can express tears and blushing through LEDs placed in the cheek regions. This allows emotionally rich expressions.

As stated above, Babyloid does not look like a human baby but can behave as one.

3 Experiment

Human babies cry when they need something from other people, especially their mothers. We evaluated what people feel when Babyloid suddenly starts to cry by changing the distance between them and the robot. In this experiment, we used three person space distances, intimate (30 cm), personal (100 cm), and social (200 cm).

3.1 Personal Space

The distance between Babyloid and people was determined using personal space proposed by Hall [7]. Personal space is the approximate area surrounding an individual into which other people should not physically violate in order for them to feel comfortable and secure. The more intimate the relationship, the less personal space is involved. Hall identified four different zones of personal space:

Intimate distance ranges from touching (0 cm) to 45 cm apart, and is reserved for lovers, children, as well as close family members, friends, and pets. We can also see more detail of their body language and look them in their eyes.

Personal distance begins about an arm's length away; starting around 45 cm from the person and ending about 120 cm away. This space is used in conversations with friends, to chat with associates, and in group discussions. At the distance, the conversation becomes more direct. This is a good distance for two people who are talking in earnest about something.

Social distance ranges from 120 to 360 cm away from the person and is reserved for strangers, newly formed groups, and new acquaintances. When they are closer, then we can talk with them without having to shout, but still keep them at a safe distance.

Public distance includes anything more than 360 away, and is used for speeches, lectures, and theater. Public distance is essentially that range reserved for larger audiences.

In this research, we used intimate, personal and social distances between Babyloid and a participant since the participant interacted with Babyloid on a one-to-one basis; therefore, public distance was not suitable for this experiment.

3.2 Experimental Process

After received informed consent forms all participants, we first asked them to fill out a pre-questionnaire. We then conducted the personal space experiment. Finally, we asked the participants to fill out a post-questionnaire.

Pre-questionnaire. To assess a person's first impression of Babyloid, we investigated her impression of Babyloid when it was not functioning. Especially, to evaluate participants' impressions of Babyloid on a two-dimensional scale, we used a rating scale of maternal feeling for babies [8]. Table 1 lists the terms of the pre-questionnaire. In this table, "closeness" means positive impression or acceptance, and "avoidance" means negative impression or rejection. Participants answered each item on the questionnaire based on a 7-point Likert scale; 7 = "agree very strongly," ..., 4 = "undecided," ..., 1 = "disagree very strongly".

Table 1. Pre- and post- questionnaire items

Closeness	Avoidance
Warm	Annoyed
Gentle	Brazen
Touching	Stressed
Heartwarming	Overfamiliar
Cheerful	Annoying
Amused	Scared
Sweet	Bothered

3.3 Experiment on Personal Space

Figure 2 shows the experimental flow. First, we gave the pre-questionnaire to all participants (30 female university students (Table 1). Second, the participants were placed into three groups (intimate, personal, and social distances) of ten individuals. Third, participants entered one at a time into the room in which Babyloid was sleeping. The participants sat the designated distance from Babyloid and acted naturally. Three minutes later, Babyloid suddenly started to cry and continued crying for one minute. Then, we entered the room and stopped the experiment. We then gave the participants the post-questionnaire and interviewed them.

3.4 Post-questionnaire

To evaluate change of impression of Babyloid, we performed a same questionnaire as the pre-questionnaire (Table 1), and we asked the following questions.

- Do you like human babies?
- Do you think you would behave the same towards a doll?

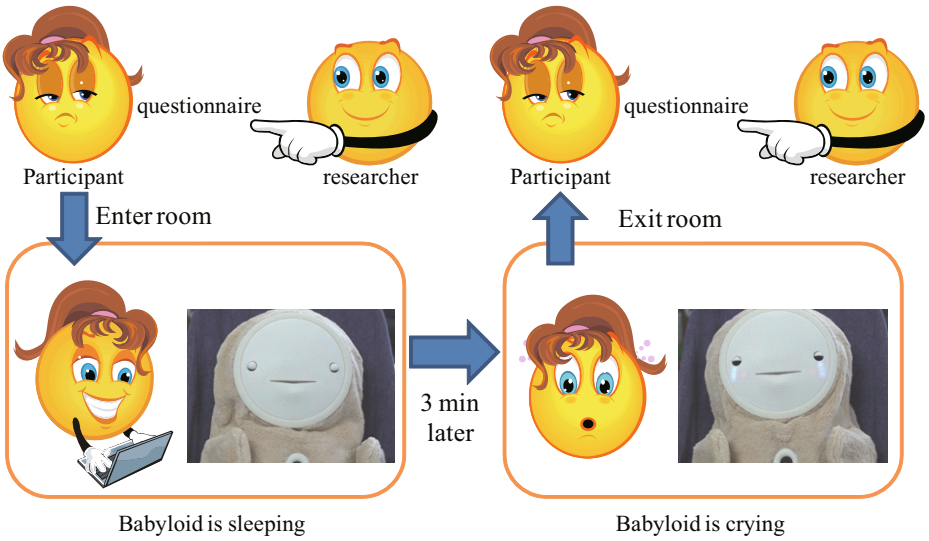

Fig. 2. Experimental flow

4 Experimental Results

To determine whether there were any differences between the three groups, we first evaluated the pre-questionnaire using the Friedman test, a nonparametric one-way analysis of variance. We found that there was no significant difference between intimate, personal, and social distances.

Second, we compared each item of the pre- and post- questionnaires. Figures 3 – 7 show the results of the Wilcoxon signed-rank test, which is a non-parametric statistical hypothesis test used when comparing two related samples. There was a significant difference between the pre- and post- questionnaires regarding intimate

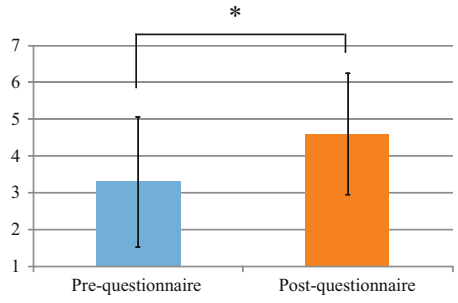

Fig. 3. Stressed (comparison with pre- and post- questionnaires regarding intimate distance)

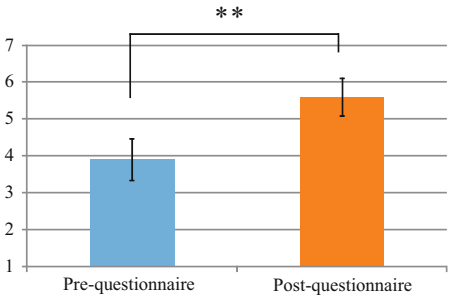

Fig. 4. Stressed (comparison with pre- and post- questionnaires regarding personal distance)

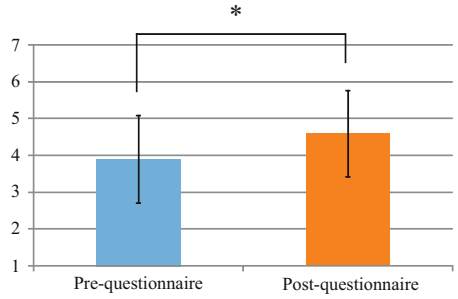

Fig. 5. Warm (comparison with pre- and post- questionnaires regarding intimate distance)

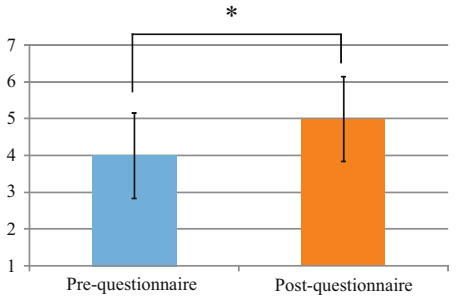

Fig. 6. Gentle (comparison with pre- and post- questionnaires regarding intimate distance)

and personal spaces for the term "stressed" (Figures 3 and 4). There was a significant difference between the pre- and post- questionnaires regarding intimate and personal spaces for the term "stressed" (Figures 3 and 4).

There was a significant difference in the terms "warm" and "gentle" regarding intimate distance (Figures 5 and 6). For the term "brazen", there was a significant difference regarding personal distance (Figure 7). There were no significant differences in the other terms. Table 2 lists the terms with significant difference.

Figures 8 and 9 show the results of the questions "Do you like human babies?" and "Do you think you would behave the same towards a doll?"

5 Discussion

From the results of Figures 3 and 4, we found that the participants at intimate and personal distances felt "stressed," because Babyloid started to crying suddenly. In Table 2, you can see that this "stressed" feeling was not felt by the participants at a social distance. Since Babyloid is assumed to be used in the user's arms, we believe

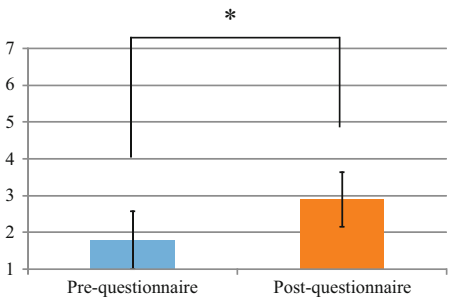

Fig. 7. Brazen (comparison with pre- and post- questionnaires regarding personal distance)

Table 2. Comparison between pre- and post- questionnaires

	Closeness	Avoidance
Intimate distance (30 cm)	Warm (*) Gentle (*)	Stressed (*)
Personal distance (100 cm)		Stressed (**) Brazen (*)
Social distance (200 cm)		

that a user would experience some kind of psychological distress if it cries at such a close proximity. When Babyloid at a personal distance cries, the user may feel "stressed" and "brazen." From Figures 5 and 6, on the other hand, the participants at an intimate distance also felt "warmly" and "gently" towards the robot. At an intimate distance, the participants had the feeling of both avoidance and closeness. Because most participants said they liked babies, the participants' psychological changes was not caused by accepting Babyloid physiologically, but by the action of "crying" (Figure 8). We therefore believe that Babyloid crying when it is in a user's arms is preferred.

From the above, inducing the strong approach feeling is difficult, but in the near distance, the possibility of inducing the behavior of protection and care was suggested. From the above results, inducing a strong caring feeling is difficult, but at an intimate distance, the possibility of inducing such behavior may be easier.

We also observed the behavior of those who said they would not behave the same way towards a doll, for example "caressing Babyloid's head," "gently stroking its body," "hugging it," and "approaching it."

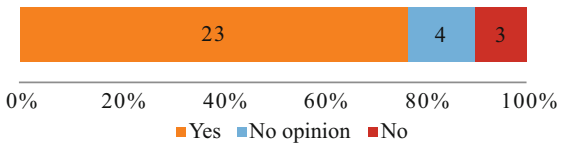

Fig. 8. Do you like human babies?

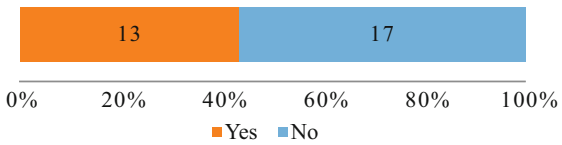

Fig. 9. Do you think you would behave the same towards a doll (not Babyloid)?

6 Conclusion

We investigated whether Babyloid induces people to want to care for or help it by focusing on the distance between them and the robot. Participants at an intimate distance felt induced to care for or help the crying robot, those at a personal distance avoided it, and those at a social distance showed neither feelings.

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