How Different Types of Animal Robots Differently Influence Elder and Younger People's Mental States?

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ABSTRACT
The research conducted a psychological experiment where both elder and younger people played with two types of animal robots (Paro and Genibo SD), to compare between their mental states before and after the play. The result based on the measurement of salivary amylase suggested that Paro influenced the decrease of stress only in the elder participants, and Genibo SD did not influence the participants' stress changes.

CCS Concepts
• **Human-centered computing → Human computer interaction (HCI) → HCI design and evaluation methods → User studies**

Keywords
Animal robots; stress; salivary amylase; POMS; elderly

1. INTRODUCTION
The recent research has found that animal-type robots can positively influence humans', in particular, elder people's mental healthcare [1]. It has been known that the seal robot "Paro" [3] has positive effects on elder people's health states [2, 4]. Some studies suggested that dog robots such as "Sony AIBO" could also be used for healthcare of elder people [5].

On the other hand, the existing studies focused on robots' effects only on single generation such as the elderly or children, and there are only a few studies comparing between generations (e.g., [6]). Thus, the following research questions have sufficiently not investigated: **1)** Whether animal robots can influence mental states of humans commonly in all the generations, **2)** Whether types of animal robots (e.g., dog or seal) cause different effects, and **3)** Whether the difference of influences caused by robot types has different aspects between generations (in other words, whether there is an interaction effect between robot types and generations).

To explore the above questions, the research conducted a psychological experiment with 2 x 2 x 2 mixed design, of which between-participant factors were generations (younger v.s. elder) and robot types (dog v.s. seal), and within-participant factor was the measurement before and after playing with the robots.

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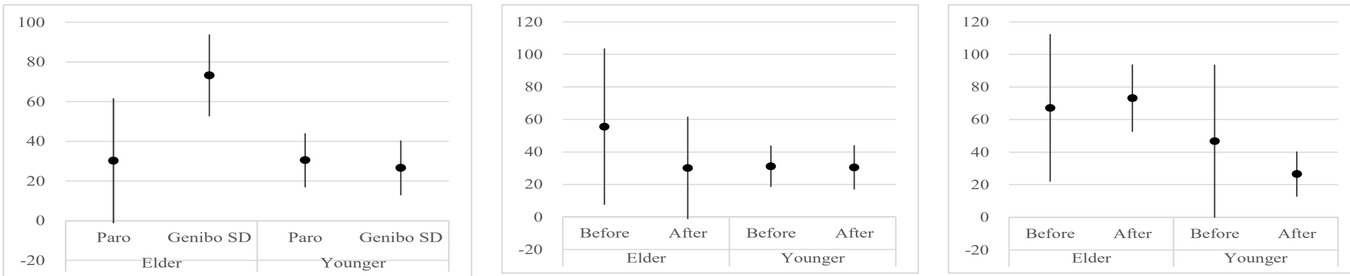
2. METHOD
The experiment was conducted from November to December 2015, in Japan. A total of twenty elder people participated with the experiment (male: 10, female: 10, age: min 60, max 71, mean 65.8). They were recruited through a survey company from the western area in Japan, with five-hundreds yen. Moreover, a total of nineteen younger people participated with the experiment (male: 11, female: 8, age: min 18, max 23, mean 20.7). They were university students in the western area of Japan, and recruited with one hundred yen.

The experiment adopted two types of autonomous animal robots. One was "Paro", a very famous seal-type robot (Figure 1 left) developed by Intelligent System, Japan. The robot has its length of 570 mm and weighs approximately 2.7 kg. Several sensors including touch ones unable the robot to autonomously respond to contact, as well as to other stimuli in its environment by moving or imitating the noises of a baby harp seal. Another was "Genibo SD", a dog-type robot (Figure 1 right) developed by Dongbu Robot, Korea. The robot has its height of 193 mm, and weighs 1.5 kg. It can autonomously perform several body motions based on many servo motors, and has a function of emotion expression based on LEDs and music-like sounds. Using speech recognition and touch sensors, the robot reacts to users' contacts. Since it can recognize only the English language, the function of speech recognition was not used in the experiment.

For measurement of stress, salivary amylase was adopted. It has recently been known that salivary amylase is one of the markers reflecting stress in humans [7]. On measurement of this physiological index, the experiment adopted "Salivary Amylase Monitor" developed by NIPRO. This measurement equipment consists of the main body (130 x 87 x 40 mm3, 190 g) and a disposable test strip. Participants' degree of salivary amylase activity is easily measured by inserting the strip into the cavity of their mice during about 10-30 seconds, and then putting it into the equipment. The normal numerical interval of measured salivary amylase is assumed to be 10 kU/l (kilo Unit per liter) ~ 200 kU/l.

Figure 1. The Robots Used in the Experiment



(a) After Playing (b) Condition of Paro (c) Condition of Genibo SD

Figure 2. Means and Standard Deviations of Salivary Amylase

3. RESULTS

Since measured values of salivary amylase were not within the normal interval in some cases, ten elder participants and two younger participants were removed in the analyses (see Table 1).

ANOVA showed neither main nor first-order interaction effect, except that the elder participants had higher values of salivary amylase than did the younger participants. The second-order interaction effect showed the statistically significant trend level ($F = 3.665$, $p = .068$, $\eta_p^2 = .132$). The results of simple interaction effect tests showed that on salivary amylase after playing with the robots interaction effect between robots and generations was at a statistically significant level ($p = .005$, $\eta^2 = .210$). A simple main effect test revealed that after playing with Genibo SD the elder participants had higher values of salivary amylase than did the younger participants ($p < .001$), and in the elder participants' group those who played with Paro had lower values of salivary amylase than did those who played with Genibo SD ($p = .002$).

The results of simple interaction effect tests also showed that in the condition of Paro interaction effect between the measurement before-after playing and generations was at a statistically significant level ($p = .015$, $\eta_p^2 = .378$). A simple main effect test revealed that in the elder participants who played with Paro the values of salivary amylase after playing were lower than those before playing at a statistically significant level ($p = .004$). This trend was not shown in the condition of Genibo SD, and the elder participants' group had higher values of salivary amylase than did the younger participants' group at a statistically significant level ($p = .045$, $\eta_p^2 = .318$).

4. DISCUSSION

The results of stress change measured by salivary amylase showed that Paro influenced the decrease of stress only in the elder participants, and Genibo SD did not influence the participants' stress change independent on generations. This finding implies that animal robots having an effect in a generation do necessarily not have the same effect in other generations. Paro may have a different effect from Genibo SD in the sense that the former more positively encourages physical contact from humans in comparison with the latter. Nevertheless, this effect was limited to the elderly in the experiment. It is estimated that this is caused by haptic characteristics of robots, and we should extend experiments focusing on this factor.

		Paro	Genibo SD
Elder	Male	3	3
	Female	2	2
Younger	Male	6	5
	Female	4	3

Table 1. Final Sample Numbers in the Experiment

On the other hand, the experiment could not have the sufficient number of samples. It may lead to the hardness of generalization of the experiment result although the effect sizes were sufficiently large in some factors. Moreover, the experiment dealt with only two negations and only two types of robots, on people in single culture. To overcome above problems, we need to extend the experiment design including more generation, more types of robots, comparing between several cultures.

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