Psychological and Social Effects to Elderly People by Robot Assisted Activity at a Health Service Facility for the Aged

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Abstract

We have been developing mental commit robots that provide psychological, physiological, and social effects to human beings through physical interaction. The appearances of these robots look like real animals such as cat and seal. The seal robot was developed especially for therapy. We have applied seal robots to assisting activity of elderly people at a health service facility for the aged. In order to investigate psychological and social effects of seal robots to the elderly people, we evaluated elderly people's moods by face scales (which express person's moods by illustration of person's faces) and questionnaires. Seal robots were provided into the facility for three weeks. As the results, feelings of elderly people were improved by interaction with the seal robots.

1. Introduction

Due to improvement of our living environment, dietary life and progress of medical, we have obtained the longest life in our history [1]. However, in most advanced countries, the number of elderly people who need nursing because of dementia, bedridden, and so on, has been increasing. Moreover, nursing staff's body and mental poverty by manpower shortage and increasing of load is becoming a big problem. Especially, mental stress of nursing causes Burnout syndrome [2]. It makes nursing staff into irritation and losing sympathy to patients. Therefore, it is important to improve "quality of life (QOL)" of elderly people because this helps them to spend their life healthily and independently. It also saves social cost for elderly people.

Animal assisted therapy and activity are becoming popular at hospital and nursing home, especially in the United States [3]. A doctor or nurse makes a program for therapy. Following three effects are expected in animal assisted therapy and activity:

(1) Psychological effect (e.g. relaxation, motivation)
(2) Physiological effect (e.g. improvement of vital sign)
(3) Social effect (e.g. activation of communication among inpatients and caregivers)

In addition to these effects, animal assisted therapy at nursing homes brings effect of rehabilitation to elderly people who have decreased his moving ability, and offers laughter and enjoyment to a patient who has few remainders of his life [4]. Moreover, there are some cases that the therapy improved state of elderly people who were dementia.

However, most hospitals and nursing homes, especially in Japan, don't accept animals even though they admit effects of animal assisted therapy and activity. They are afraid of negative effects of animals to human beings such as allergy, infection, bite, and scratch.

We have been building animal type robots as examples of artificial emotional creatures [5-15]. The animal type robots have physical bodies and behave actively while generating goals and motivations by themselves. They interact with human beings physically. When we engage physically with an animal type robot, it stimulates our affection. Then we have positive emotions such as happiness and love, or negative emotions such as anger and fear. Through physical interaction, we develop attachment to the animal type robot while evaluating it as intelligent or stupid by our subjective measures. In this research, animal type robots that give mental value to human beings are referred to as "mental commit robot." We

have developed cat robot and seal robot as the mental commit robot.

We have applied seal robots as substitution of real animals to therapy of children at a university hospital [12]. This was referred to as robot-assisted therapy (RAT). Moods of children were improved by interaction with the robot. Moreover, the robot encouraged children to communicate with each other and caregivers. In one striking instance, a young autistic patient recovered his appetite and his speech abilities during the weeks when the robot was at the hospital. In another case, nurses noted the rehabilitative benefits for a long-term patient, unable to leave her bed, who was willing to stroke and pet the animal.

In addition, we have applied seal robots to robot-assisted activity (RAA) for elderly people [13-15]. The robots improved their moods and brought vigor to them. Moreover, nursing staff's mental poverty decreased because the elderly people spent their time by themselves with the robots.

In this paper, we applied seal robots to assist activity of elderly people at a health service facility for the aged, in order to investigate psychological and social effects of seal robots to the elderly people. Then, we compared with effects of the seal robot and those of a placebo seal robot that was changed its motion generation program.

Chapter 2 explains a seal robot and placebo seal robot that were used for RAA. Chapter 3 describes ways of experiments and explains the effects of RAA to elderly people. Chapter 4 discusses current results of RAA and future works. Finally, chapter 5 concludes this paper.

2. Seal Robot and Placebo Seal Robot

2.1. Specifications of Seal Robot

Seal robot, Paro was developed to have physical interaction with human beings (Fig.1). Paro's appearance is from a baby of harp seal, which has white fur for three weeks from its born. As for perception, Paro has tactile, vision, audition, and posture sensors beneath its soft white artificial fur. In order for Paro to consist of a soft body, a tactile sensor was developed and implemented. As for action, it has seven actuators; two for each eyelids, two for neck, one for each front fin, and one for two rear fins. Weight of Paro is about 3.0 [kg].

Paro has a behavior generation system that consists of hierarchical two layers of processes: proactive and

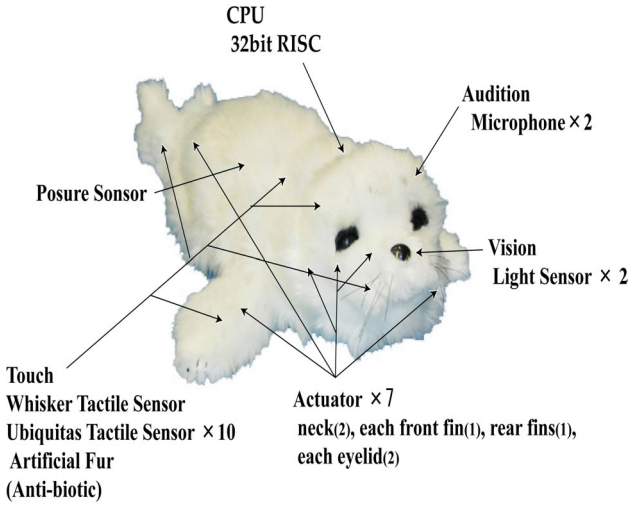


Fig.1 Seal Robot "Paro"

reactive processes. These two layers generate three kinds of behaviors; proactive, reactive, and physiological behaviors:

(1) Proactive Behaviors: Paro has two layers to generate its proactive behaviors: behavior-planning layer and behavior-generation layer. Considering internal states, stimuli, desires, and a rhythm, Paro generates proactive behaviors.

(a) Behavior-planning layer: This has a state transition network based on internal states of Paro and Paro's desire produced by its internal rhythm. Paro has internal states that can be named with words of emotions. Each state has numerical level and is changed by stimulation. The state decays by time. Interaction changes internal states and creates character of Paro. The behavior-planning layer sends basic behavioral patterns to behavior-generation layer. The basic behavioral patterns include some poses and some motions. Here, although "proactive" is referred, proactive behaviors are very primitive compared with those of human beings. We implemented similar behaviors of a real seal into Paro.

(b) Behavior generation layer: This layer generates control references for each actuator to perform the determined behavior. The control reference depends on strength of internal states and their variation. For example, parameters change speed of movement, and the number of the same behavior. Therefore, although the number of basic patterns is countable, the number of emerging behaviors is uncountable because numeral parameters are various. This creates living like behaviors. In addition, as for attention, the behavior-generation layer adjusts parameters of

priority of reactive behaviors and proactive behaviors based on strength of internal states. This function contributes to situated behavior of Paro, and makes it difficult for a subject to predict Paro's action.

(c) Long-term memory: Paro has a function of reinforcement learning. It has positive value on preferable stimulation such as stroked. It also has negative value on undesirable stimulation such as beaten. Paro put values on relationship between stimulation and behaviors. Gradually, Paro can be shaped to preferable behaviors of its owner.

(2) Reactive behaviors: Paro reacts to sudden stimulation. For example, when it hears big sound suddenly, Paro pays attention to it and looks at the direction. There are some patterns of combination of stimulation and reaction. These patterns are assumed as conditioned and unconscious behaviors.

(3) Physiological behaviors: Paro has a rhythm of a day. It has some spontaneous desires such as sleep based on the rhythm.

2.2. Specifications of Placebo Seal Robot

We often experience that we lose interest in toys when we found its mechanism. Therefore, we consider following hypothesis:

The robots that execute only defined simple motions are predicted its motions by people, and they lose interest in the robots. Moreover, the robots also lose its effects to the people.

According to this hypothesis, we changed regular Paro's program, and made placebo Paro as follows.

Proactive behaviors: repetition of following five kinds of actions.

(1) Blink
(2) Swing rear fin to right and left
(3) Swing both front fins to forward and backward
(4) Swing head to right and left
(5) Cry

Reactive behaviors: following simple reactions against stimuli.

(1) Cry (sound is different from proactive motion's cry)
(2) Raise head

3. Robot Assisted Activity for Elderly People

We applied Paro to robot-assisted activity for elderly people at a health service facility for aged in order to investigate its effects on elderly people. The health service facility for aged is an institution that provides several services, such as stay in the institution, day care and rehabilitation to elderly people. People who need nursing can stay in there during a certain period. In order to rehabilitate into society, they are provided daily care and trained to be able to spend their daily life independently during their staying at the institution. When we started experiment at the institution, about 100 elderly people were staying in there. Moreover, about 30 people of them were dementia. People who were not dementias stayed in A and B building. On the other hand, people who were dementia stayed in C building, and they were isolated from other people.

Table 1 Basic Attribute of 23 Subjects

	A	B
Total number of people	12	11
Male	4	2
Female	8	9
Age(AV±SD)	84.6±7.0	85.5±5.4

Fig.2 Interaction between Elderly People and Paro

Before starting the robot-assisted activity, we explained the purposes and ways of the experiment to elderly people who stayed A and B building, and received their approval. Symptoms of the elderly people who approved the investigation were various with different reasons (no answer to questionnaires, bedridden, etc). Some people were impossible to be investigated. Then, a nursing staff that knew usual states of the elderly people well evaluated them, and decided who could be investigated. After the

evaluation, the number of subjects was 23. 12 subjects stayed in A building, and 11 subjects were in B building. Their basic attributes are shown in Table 1.

3.1. Ways of activity

Regular Paro was provided to the subjects who stayed in B building, and placebo Paro was provided to the subjects who stayed in A building. In order to prevent that subjects of each group interact with other group's Paro, they interacted with each group's Paro in different place in the facility. Moreover, we kept the existence of two kinds of Paro secret from subjects. Each groups interacted with each Paro about one hour at a time, four days a week for three weeks. We prepared a desk to set Paro in the center of people, and the subjects were arranged up as shown Fig.2. However, all the subjects couldn't interact with Paro at the same time. Therefore, we moved Paro among subjects in turn, and we made each subject's interaction time with Paro to be same.

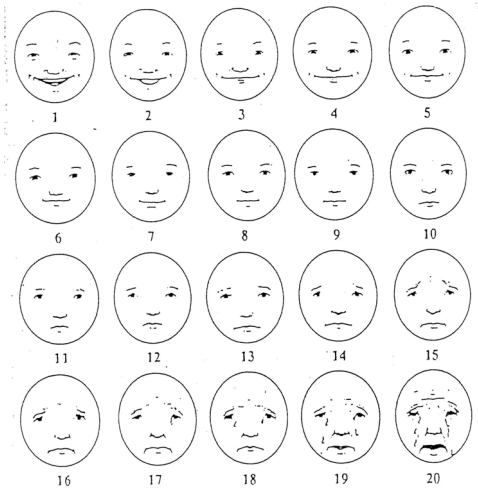
3.2. Ways of evaluation

In order to investigate elderly people's moods before and after introduction Paro to the institution, the following two kinds of data and extra information were collected.

(1) Face scale [16] (Fig.3)
(2) Profile of Mood States (POMS) [17]
(3) Comments of nursing staffs

The Face Scale contains 20 drawings of a single face, arranged in serial order by rows, with each face depicting a slightly different mood state. A graphic artist was consulted so that the faces would be portrayed as genderless and multiethnic. Subtle changes in the eyes, eyebrows, and mouth were used to represent slightly different levels of mood. They are arranged in decreasing order of mood and numbered from 1 to 20, with 1 representing the most positive mood and 20 representing the most negative mood. As the examiner pointed at the faces, the following instructions were given to each patient: "The faces below go from very happy at the top to very sad at the bottom. Check the face which best shows the way you have felt inside now."

POMS is one of popular questionnaires, which measures person's moods [17]. POMS is used in various research fields such as medical therapy and psychotherapy. It can measure six mood states at the same time: Tension-Anxiety, Depression-Defection, Anger-Hostility, Vigor, Fatigue, and Confusion. It has 65 items concerning moods. Each items were



INSTRUCTIONS: The faces above go from very happy at the top to very sad at the bottom. Check the face which best shows the way you have felt inside now

Fig.3 Face Scale

evaluated by five stages of 0-4: 0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, and 4 = extremely. 58 of 65 items are classified into the six mood states, and we calculate total scores of each mood states. (Note: 7 items are dummy items) Then, we translate the total scores into standard scores by using special table.

3.3. Results of evaluation

The face scale and POMS were applied to subjects, a week before introduction of Paro, 2nd and 3rd week after introduction.

As for face scale, we obtained data from 11 people of placebo Paro group, and from 7 people of regular Paro group. Fig.4 shows average face value. Average scores of regular Paro group decreased from about 9.0 (before introduction) to 7.0 (3rd week). Moreover, placebo Paro group's average scores also decreased from about 7.0 (before introduction) to 6.3 (3rd week). Therefore, interaction with regular and placebo Paro improved mood of subjects.

As for POMS, we obtained data from 9 people of placebo Paro group, and from 3 people of regular Paro group. Fig.5 shows average standard scores of Depression-Dejection. Here, 50 standard points means average score of Depression-Dejection of over 60 years old Japanese people. Average standard scores of regular Paro group decreased from about 61 (before introduction) to 47 (3rd week). Moreover, placebo Paro group's average standard scores also decreased from about 58 (before introduction) to 51 (3rd week).

Therefore, interaction with regular and placebo Paro improved depression and dejection of subjects. As for other factors such as "Tension-Anxiety", "Anger-Hostility", "Fatigue" and "Confusion" also decreased. However, these scores didn't change as large as "Depression-Dejection". As for "Vigor", its scores decreased. We think that it means people relaxed and calmed down by interaction with Paro.

As for comments and observations of nursing staffs, both groups of subjects were waiting for Paro and participated interaction with Paro willingly. Paro increased their laughing, and encouraged subjects to communicate with each other and nursing staffs. In an interesting instance, an elderly man who was fastidious and difficult to communicate with other people, sang songs to Paro with big voice many times, and he made other people laughing. Another elderly made a song of Paro and sang it to Paro.

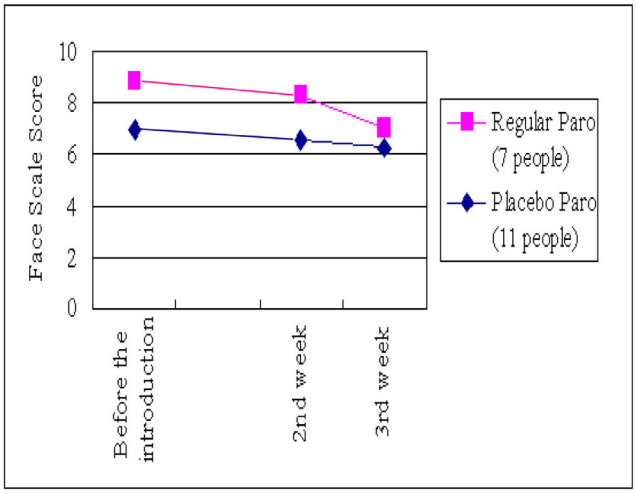


Fig.4 Average Face Scale Scores of Elderly People for 4 weeks

4. Discussions

We investigated the effects of Paro on elderly people who were staying in health service facility for the aged. Moreover, we compared the effects by the regular Paro with those by a placebo Paro. Against our expectation, face scale scores of regular and placebo Paro groups improved, and their standard scores of Depression-Dejection of POMS decreased after introduction of Paro. From these results, regular and placebo Paro improved elderly people's moods. Especially, Paro was effective to their depression.

Before experiment, we expected that people would lose interest in placebo Paro, because its reaction was very simple. However, subjects of placebo Paro group didn't lose interest in the placebo. They kept interaction with placebo Paro, and they didn't notice that placebo Paro's reaction was simple.

As for this fact, we consider following reasons:

(1) It was difficult for subjects to notice that placebo Paro's reaction was one pattern.

Subjects interacted with Paro in two or more people at the same time. Therefore, each subject's interaction time with Paro was not as long as they could notice that its reaction was one pattern.

(2) Reaction that cry and raise its head had special meanings.

Some subjects said "good boy" when Paro raised its head. They felt that Paro answered their calling.

In order to clarify these points, we will carry out experiments that use more number of Paro, and

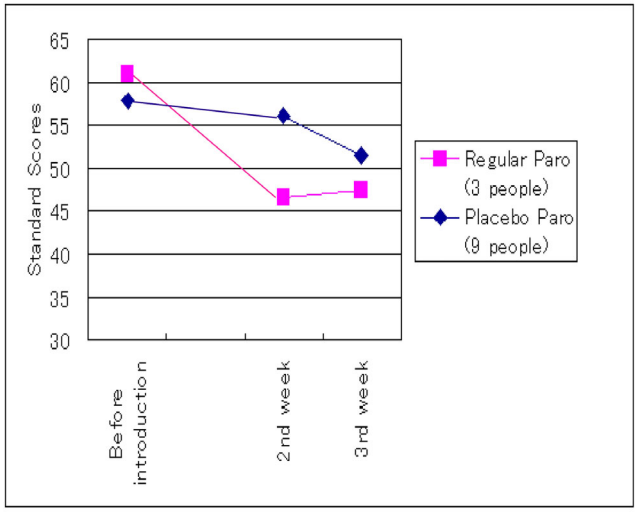


Fig.5 Average Standard Scores of "Depression-Dejection" of POMS of Elderly People for 4 weeks

compare the effects of Paro, those of the placebo Paro and those of another placebo Paro that swing its head to right and left against stimuli.

In this research, we used questioners, POMS, because it can measure six mood states accurately. However, it had many items, and some subjects refused to answer it with passage of time. We will make more simple questioners that measure moods of elderly people.

5. Conclusions

We applied seal type mental commit robots, Paro to robot-assisted activity for elderly people at a health service facility for the aged. The experiment was carried out for 4 weeks in total. Then, we compared the effects by the regular Paro with those by a placebo Paro. The results show that interaction with regular and placebo Paro has psychological effect and social effect to elderly people.

We will have further experiments and research in different conditions and situations. Moreover, we will investigate relationship between functions of a mental commit robot and its effects to elderly people in robot-assisted activity.

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