Change of Stress Reaction by Introduction of Mental Commit Robot to a Health Services Facility for the Aged

Tomoko SAITO*[1], Takanori SHIBATA*[1,2], Kazuyoshi WADA*[1,3] and Kazuo TANIE*[1,3]
*[1] Intelligent Systems Institute, AIST, *[2] PRESTO, JST , *[3] University of Tsukuba,
1-1-1 Umezono, Tsukuba, Ibaraki, 305-8568 Japan
{tomo-saito, shibata-takanori, k-wada, tanie.k}@aist.go.jp

Abstract-We introduced mental commit robot to a health services facility for the aged. The purpose was to clarify relationship between interaction with the robot and change of stress reaction by the level of 17-KS-S and 17-OHCS value in urine of elderly, as well as to investigate potential beneficial effects on health of the elderly. A seal type mental commit robot was provided to the elderly four days a week for three weeks. Besides, we used the questionnaire concerning familiarity with the robot that was introduced as an index of the psychological influence that mental commit robot give the subjects. Moreover, it was shown that the introduction of mental commit robot had produced a good influence for the reduction of nursing staff's stress.

1. Introduction

In various countries throughout the world, the relationship between people and pets has been thoroughly researched, elucidating the psychological and physiological benefits that keeping pets can have for people [1-6]. Moreover, dogs, cats, and other pets have come to be called companion animals in recent years [7]. When the health degree is investigated in the United States, the item "Breeding of the pet" is seen in the item of emotional happiness besides physical activity, nutrition, and disease prevention [8]. This is based on a lot of researches on the good influence from a pet to a human's health.

In the physiologic effect which the pet gives man, it is reported that the blood pressure value and the cholesterol value decreases by touching and seeing the animal [9].

There is the result of investigation that dog owners' frequency of going to hospital regularly is less than non-keeping pets, when they are compared with the frequency of going to hospital regularly, too [10]. Moreover, in a 10-month prospective study examined changes in behaviour and health status in 71 adult subjects following the acquisition of a new pet (either dogs or cats), both pet-owning groups reported a highly significant reduction in minor health problems during the first month, and this effect was sustained in dog owners through to 10 months. In addition, they also showed improvement in their scores on the GHQ (General Health Questionnaire) over the first 6 months and, in dog owners, this improvement was maintained until 10 months [4].

There is a research that the existence of the pet has a constant effect for the stress with a large loss of the death of a spouse or an intimate friend [11].

In general, it is said that keeping a pet is good for health. However, there is a lot of elderly who cannot keep a dog or a cat even if wanting to keep them because of the worry of common infectious disease between men and beasts. Moreover, it is difficult to take animals into hospitals and elderly institutions.

By now, authors have researched and developed "mental commit robot" which aims for therapy. We verified the effects of hospitalized children's QOL improvement in the infantile ward. It was confirmed that the introduction of the robot was useful for the improvement of the desire of leaving hospital and for the improvement of symptom as autism [12].

On the other hand, as a method of measuring the stress, it is possible that we evaluate physiology by using urinary tests which are the inspection method handiness and non-infestation for elderly [13]. We had conducted research on elderly living at home assubjects using the index of urine 17-Ketosteroid sulfates (17-KS-S) and 17-hydroxycorticosteroids (17-OHCS), and had obtained the result that elderly who were keeping the companion animal had excellent adaptability to the stress [14].

In this study, we introduced mental commit robot to an elderly institution, and examined the change of stress reaction of elderly by urine 17-KS-S value and the 17-OHCS value before and after introduction of mental commit robot.

2. Mental Commit Robot

Mental commit robot (Fig.1) was developed to have physical interaction with human beings. Robot's appearance is from a baby of harp seal, which has white fur for three weeks after its born. As for perception, seal robot has tactile, vision, audition, and posture sensors beneath its soft white artificial fur. In order for the robot to consist of a soft body, an air-bag type tactile sensor was developed and implemented. As for action, it has eight actuators; two for upper and lower eyelids, one for rotation of eyes, two for neck, one for each front fin, and one for two rear fins. Weight of the seal robot is 2.8 kg [15].

The seal robot has a behavior generation system that consists of hierarchical two layers of processes: proactive and reactive processes. These two layers generate three kinds of behaviors; proactive, reactive, and physiological behaviors:

A. Proactive Behaviors

The robot has two layers to generate its proactive behaviors: behavior-planning layer and behavior-generation layer. Considering internal states, stimuli, desires, and a rhythm, seal robot generates proactive behaviors.

(a) Behavior-planning layer: This has a state transition network based on internal states of robot and robot's desire produced by its internal rhythm. The robot 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 the robot. 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 the robot.

(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 robots, and makes it difficult for a subject to predict robot's action.

Fig.1 Seal Robot "Paro"

(c) Long-term memory: The robot 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. The robot put values on relationship between stimulation and behaviors. Gradually, the robot can be shaped to preferable behaviors of its owner.

B. Reactive behaviors: Seal robot reacts to sudden stimulation. For example, when it hears big sound suddenly, the robot 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.

C. Physiological behaviors: The robot has a rhythm of a day. It has some spontaneous desires such as sleep based on the rhythm.

3. 17-KS-S, 17-OHCS

Selye regarded stress as the rate of wear and tear and 17-OHCS as its indicator [16]. But Nishikaze et al. considered that living organisms, unlike inanimate objects, exist in a dynamic balance between "wear and tear" and "repair and recovery," and sought for a compound related to tissue "repair and recovery," and they discovered 17-KS-S in urine [17]. 17-KS-S value shows the descent by the ageing, progress of the disease or social psychology stresses.

Though 17-OHCS value rises at the stress, 17-KS-S shows high level in healthy individuals and decrease with failing health or the progress of disease [18]. In addition, 17-KS-S value shows a sensitive change by psychological and social factor, and relates greatly to person's will, desire, and energy [18]. 17-KS-S/17-OHCS which is the value into

17-KS-S is divided with 17-OHCS, is a method of enabling the grasp of the distortion of the living organisms brought by stressor and understanding the living organisms reaction inclusively [18]. It is reported that 17-KS-S/17-OHCS is indicated clear low value (0.15 or less) under social psychology stress and rises with release of stress cause [17]. Both 17-KS-S value and 17-OHCS value are shown in ratio to Creatinine (mg/g Creatinine). As a result, the influence of the physique (such as racial difference and sex difference) decreases [18].

4. Methods

In order to investigate its effects on elderly, we introduced mental commit robot to a health services facility for the aged for three weeks from November to December 2001. A health services facility for the aged is an institution that aims to provide nursing care and rehabilitation services to enable elderly who do not need to be hospitalized to return home. Capacities in facilities for the experiment are 100 people. The elderly of 30 people for each who are health or a light dementia symptom live in ward-A and ward-B, and 30 elderly who have the heavy dementia symptom live in ward-C. Users' stay period of average is three months. The total staff is 30 people (18 nurses and 12 care attendants). At first of the experiment, it was rotation work by which the work of ward-A, ward-B, and ward-C was alternated in two months. About choosing a suitable person of the subjects, the staff of nurses explained the content of the experiment to the elderly, and decided 30 people (ward-A: 15, ward-B: 15) from the person who had agreed. We excluded the elderly with a heavy dementia symptom of ward-C from the collection of urine, for the reasons of difficulty of taking their urine. Moreover, we also excluded the person who was taking the medicine which influenced the urine value. Informed consents were obtained by themselves those who live or their family.

We used two type robots for the experiment, which one is original mental commit robot Paro that is able to do complex operation, and another one is the robot that can do only simple operation as a comparison contrast. Original robot Paro (henceforth Paro B) introduced to ward-B, Paro of the comparison contrast (henceforth Paro A) into ward-A. Each subjects of A and B interacted with Paro in a different place not to touch mutually to another Paro.

Paro A was made 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

A seal robot was provided to the elderly four days a week for three weeks. We prepared a desk to put the robot in the center of people, and the elderly sat around the table. The elderly interacted with the robot for about one hour at a time. Because the number of people was large, elderly people could not interact with the robot at the same time, so we sequentially moved the robot among the elderly.

Urine was gathered in the early morning and was analyzed after frozen preservation by -18 degrees afterwards gathering. Each value was corrected with the creatinine. We gathered the urine three times, before introduction, after one week of the introduction, and after two weeks.

We interviewed them concerning life events by social readjustment rating scale of Holmes and Rahe [19] which happened in one week before gathering urine and we considered the influence on the urine value.

Besides, we used the questionnaire concerning familiarity with the robot which was introduced etc. as an index of the psychological influence which mental commit robot give the subjects. The questionnaires have 3 items: I like the robot, I speak to the robot, and the robot is the best friend for me. These items were evaluated by five stages: 0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, and 4 = extremely.

We used Wilcoxon signed rank test for the comparison of the urine values before and after the introduction of mental commit robot.

Statistical analyses were performed with the statistical program SPSS10.0J for Windows.

5. Results and Discussions

Analytical subjects were twenty-three persons, because there were drop out person. Moreover, final analytical subjects were twenty-two, by exclusion coming off value.

Table 1 The change before and after the introduction

17-OHCS	Before	Second week	
Ward-A	7.90±2.43	8.22±3.32	ns
Ward-B	6.66±2.20	8.82±2.31	*
17-KS-S	Before	One week after	
Ward-A	1.97±1.09	1.17±0.51	*
Ward-B	1.76±0.59	2.46±1.42	*
17KS-S/17-OHCS	Before	One week after	
Ward-A	0.26±0.15	0.15±0.07	*
Ward-B	0.30±0.16	0.31±0.25	ns

Ward-A (n=12), Ward-B (n=11) Average±SD
Wilcoxon signed rank test * $p<0.05$

As for ward-A, the numbers of subjects were twelve, which include eight women and four men. Average and standard deviation of their age were 84.6±7.0 years, and the highest was 96 years old. There were four subjects who were light dementia.

As for ward-B, the numbers of subjects were eleven, which include nine women and two men. Average and standard deviation of their age were 81.6±9.3 years, and the highest was 93 years old. Five subjects were light dementia. There were no significant differences in the average age of the ward-A and ward-B (T tests).

Table 1 shows 17-OHCS value that indicates the stress load degree, 17-KS-S value that indicates the restoration degree to the stress, and ratio of 17-KS-S/17-OHCS that indicates an inclusive living organisms reaction before the introduction of robot and the second week. The stress load degree of ward-A and ward-B went up, especially ward-B was significant. The restoration degree of ward-A decreased, and that of ward-B went up significantly. An inclusive living organisms reaction of ward-A decreased, and that of ward-B was in the increasing tendency.

In Paro A of simple operation, the inclusive living organisms reaction of subjects of ward-A seen from the urine value has deteriorated though they answered "I like Paro" their impression about Paro in the questionnaire.
If we thought about the cause, it was thought not to be able to gather the early morning urine in ward-A for the convenience of the work of the nurses in the next day when subjects interacted with Paro, and collection of the following urine have become after a few days.

The early morning urine of four people were able to be gathered in ward-B on the next day of the interaction. Therefore, we showed the change of the urine value before and after the introduction of subjects who were able to be gathered their early morning urine of the next day of

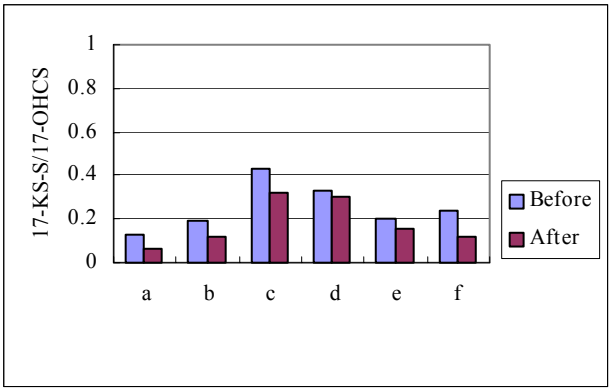

Fig. 2-1. The change of 17-KS-S/17-OHCS
(Subjects who became not favorite Paro)

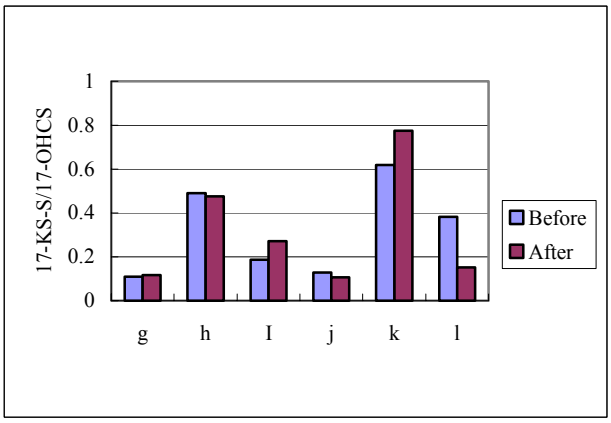

Fig. 2-2. The change of 17-KS-S/17-OHCS
(Subjects who like Paro)

interaction including the third week of the introduction. They were shown in Fig.2.1 and Fig.2.2.

Fig.2.1 showed the object person who did not like Paro at the time of beginning or whose degree of the favor greatly decreased. An inclusive living organisms reaction had deteriorated. Fig.2.2 showed the person who had liked Paro at the time of beginning or whose degree of the favor decreased small. An inclusive living organisms reaction rose or was a level-off.

Fig.3 shows the appearance of interactions between elderly and Paro at the health services facility for the elderly. One man talked toward Paro loudly "Dad has come", and often laughed. There was a woman who sang toward Paro the song that she had made for Paro, too.
In the comment of the nursing staff on the experiment, they wrote that the elderly who were quiet usually often laughed, and it was different from the usual appearance.

Fig.3 Interaction between elderly people and Paro at a Health Services Facility for the Aged

Next, the change of the urine value of the nursing staff is shown in Fig4-1, Fig 4-2, and Fig 4-3.

For the staff in charge of ward-C which had dementia's elderly, the value of 17- OHCS which showed wear and tear by the stress had risen compared with the staff in charge of ward-A and ward-B. In the nursing of the elderly of the dementia in ward-C, it was proven by the urine value that nurse's stress degree was high. 17- KS-S value by which the restoration of the stress was shown had risen in a staff in charge of ward-A. Moreover, 17- KS-S/17-OHCS which showed an inclusive living organisms reaction had risen in a staff in charge of ward-A, too. As the reason, in ward-A, the fact that there were a lot of independent elderly, so the load of the charge staff was small, was thought. Moreover, that a usual appearance of the elderly became to be different by having introduced Paro was thought as reason.

6. Conclusions

We introduced mental commit robot to an elderly institution, and examined the change of stress reaction of elderly by urine 17-KS-S value and the 17-OHCS value before and after introduction of robot. As the results, an excellent adjustment ability to the stress was shown, and mental commit robot had a useful possibility for maintenance of health of elderly. Moreover, it was shown that the introduction of mental commit robot had produced a good influence for the reduction of nursing staff's stress.

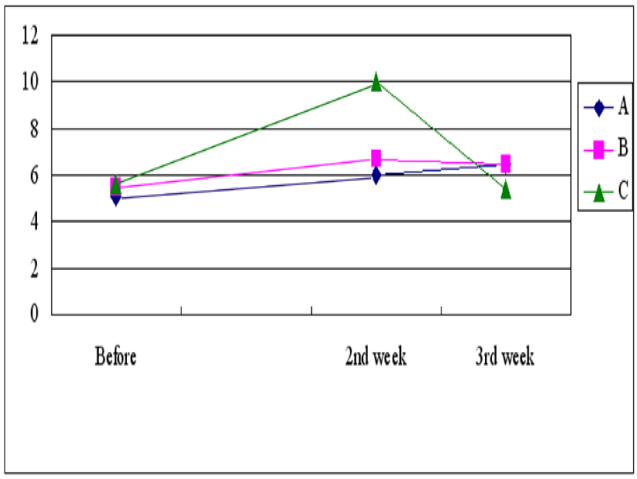

Fig. 4-1. The change of 17-OHCS value of nurses and care attendants

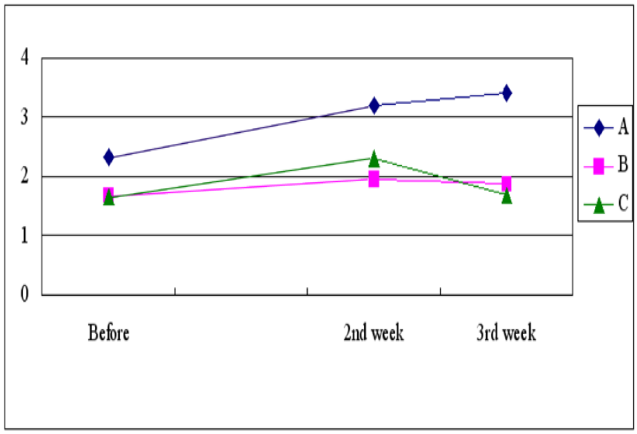

Fig. 4-2. The change of 17-KS-S value of nurses and care attendants

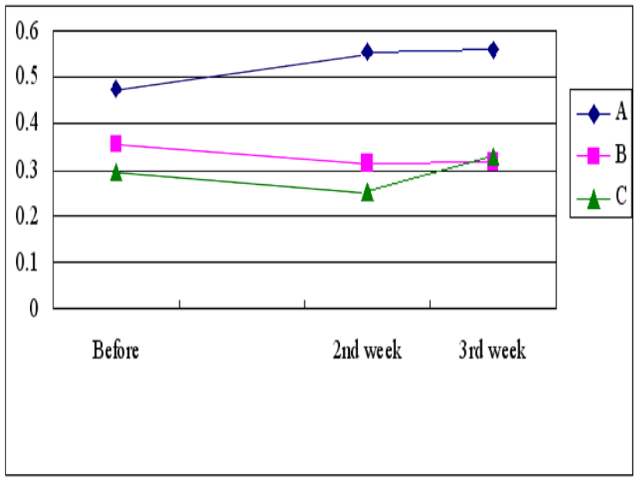

Fig. 4-3. The change of 17-KS-S/17-OHCS of nurses and care attendants

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