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Chapter 33

Eating Behavior of Dementia Patients

A Self-Awareness Model to Understand the Puzzling Eating Behavior of Dementia Patients

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LIST OF ABBREVIATIONS

CDR Clinical Dementia Rating
QOL quality of life
BPS behavioral and psychological symptoms of dementia

INTRODUCTION

Perspectives from Which to Understand the Puzzling Eating Behavior of Dementia Patients

To the extent that we were able to determine in a search of the literature on the puzzling eating behavior of dementia patients, it has been explained on the basis of each of their individual cognitive impairments (amnesia, aphasia, apraxia, agnosia, apathy, attentional disorder, affective disorder, impaired judgment, executive dysfunction) [1–6]. However, it cannot be explained on the basis of cognitive impairments alone.

For example, some dementia patients put things that are not food into their mouths. Is that because of impaired judgment? That cannot explain it. The problem is why they are unable to judge. Is it because of agnosia? Agnosia is "an impairment of object recognition through a certain sense; it is a pathological condition that cannot be ascribed to an abnormality of the organ of that sense, to intellectual deterioration, to a consciousness disorder, or to an attentional disorder, and if another sense is used, the object can be recognized" [7]. The phenomenon of putting things that are not food into the mouth occurs after intellectual deterioration has progressed considerably, and it cannot be explained by agnosia. Moreover, it is impossible to determine whether recognition is possible if another sense is used.

There are dementia patients whose table manners deteriorate, who, for example, eat with their hands and lick the dishes. Are they unable to use chopsticks or a spoon well because of apraxia? Apraxia is "a condition in which a person is unable to execute purposeful movements despite the absence of paralysis of their motor apparatus, ataxia, etc., or any clear abnormalities in the cognitive area, such as in comprehension" [8]. Loss of table manners also occurs after intellectual deterioration has progressed considerably, and it is unreasonable to explain it on the basis of apraxia.

When the deterioration of table manners becomes profound, some patients fail to swallow the food in their mouth. Meal assistance then takes a long time, and it becomes very difficult for the caregiver. Do patients forget that there is food in their mouth because they cannot see inside their mouth? However, they fail to swallow even when a mirror is placed in front of them so that they can see inside their mouth. Could that be because of buccofacial apraxia? Buccofacial apraxia is a "condition in which execution of intentional acts that involve using the muscles of the larynx, pharynx, tongue, lips, and cheeks is impaired, but automatic movements are preserved" [9]. It is clearly unreasonable to explain failure to swallow on the basis of apraxia without being able to determine whether the actions of dementia patients are intentional or automatic. More than being a memory or apraxia problem, the problem is why they fail to notice.

Thus, even if we explain the puzzling eating behavior of dementia patients on the basis of cognitive impairments, it is only possible to explain one aspect of it. A look at the definition of dementia makes it clear why even a patchwork of individual cognitive impairments cannot explain the puzzling eating behavior of dementia patients. The common definition

Diet and Nutrition in Dementia and Cognitive Decline.

of dementia is a condition in which all of the intelligence that had been acquired continually diminishes as a result of a brain disorder, and social life and everyday living on one's own become impossible. In other words, dementia is a condition in which daily life becomes impossible because all of one's intelligence decreases, not just some of it. Consequently, an approach that is based on human intelligence and the human mind as a whole is needed to explain the puzzling words and deeds of dementia patients. In brief, it must be perceived on the basis of the ego and self-awareness. That is the first perspective of this chapter that examines the puzzling eating behavior of dementia patients. Because the concept of ego varies considerably from investigator to investigator, in this chapter we viewed it from the perspective of self-awareness.

The second perspective is that because self-awareness diminishes in dementia, it becomes impossible to maintain a relationship with oneself or with others, and daily life on one's own becomes impossible. If there is amnesia, taking notes can make daily life possible. If there is agnosia, other senses can be used. If a patient has apraxia, the patient can ask someone for help. No matter what the cognitive impairment and no matter how severe the physical disability, as long as one is able to be aware of one's own mind and other people's minds, it is possible to go about one's daily life by conveying one's mind to others and asking them for assistance.

INTELLIGENCE THAT HAS EVOLVED IN ORDER TO DEAL WITH COMPLEX INTERPERSONAL RELATIONS

The social intelligence hypothesis, which states that human "intelligence" has evolved in order to adapt to complex interpersonal relations [10,11], is generally accepted in the current theory of evolution. It is based on the fact that there is a clear correlation between the relative size of the neocortex of the brains of primate species in relation to other parts of their brains and the mean size of their groups (social brain hypothesis) [12]. In other words, it is thought that as the size of the group increases, it becomes necessary to adapt to more complex social relationships within the group, and that is why the neocortex has increased in size.

Moreover, research subjects in brain science in this century have also been focusing on the individual operations of the brain (social brain) that adapt to complex interpersonal relations based on individuals' memory, aphasia, apraxia, agnosia, etc. The trigger that propelled research on the social brain forward was the discovery by Rizzolatti et al. in 1992 that neurons in the ventral premotor cortex of monkeys became active whether the monkey performed an action itself or a person, whom the monkey was watching, performed the action (mirror neurons) [13], and such neurons were later found in humans as well [14–16]. In addition, neurons that interpret the goals of others' actions [17], neurons that interpret the intentions of others' acts [18], and neurons that interpret the context that lies in the background of others' acts [19] have been reported. In other words, these neurons reflect one's own mind and the mind of others like a mirror, and link them.

A function that connected one's own mind and the minds of others was postulated in psychology 15 years before the discovery of mirror neurons. It is the "theory of mind." It all began when the animal behavioral psychologists Premack and Woodruff [20] focused on the behavior of chimpanzees that deceived other chimpanzees in order to obtain food and wondered whether chimpanzees could read the minds of others. By using "false-belief tasks," which evaluate whether another person holds a belief that differs from the actual situation, Wimmer and Perner [21] later demonstrated that between 4 and 6 years of age is when children are able to acquire a "theory of mind," i.e., the ability to infer mental states (intention, thought, belief, desire, emotion, etc.) that are in the background of the behaviors of oneself and others and cannot be directly observed.

A SELF-AWARENESS MODEL IN ORDER TO UNDERSTAND THE PUZZLING WORDS AND DEEDS OF DEMENTIA PATIENTS

If it is true that "intelligence" developed in order to deal with complex interpersonal relations, then a decrease in "intelligence" would deprive one of the ability to deal with complex interpersonal relations. We therefore constructed a process in which infants adapt to complex interpersonal relations based on the developmental psychologist Michael Lewis's cognition and emotions development model [22,23] and Perner et al.'s, "theory of mind" (Figure 33.1), and perceiving the opposite to be a process in which dementia patients cannot adapt to complex interpersonal relations, we created a "model that interprets the puzzling words and deeds of dementia patients" [24–27] (the self-awareness model) (Table 33.1).

According to Lewis (Figure 33.1), human beings are born with the emotions "contentment," "interest," and "distress," and emotions such as "joy," "surprise," "anger," branch out and develop as they relate to other people, such as their mother. When infants reach about 18 months of age, they become aware of their own existence, and "self-consciousness," by which they distinguish between themselves and others, emerges, and the self-conscious emotions "embarrassment" and "empathy" develop. Between 2.5 and 3 years of age, children understand the rules and standards of the society in which

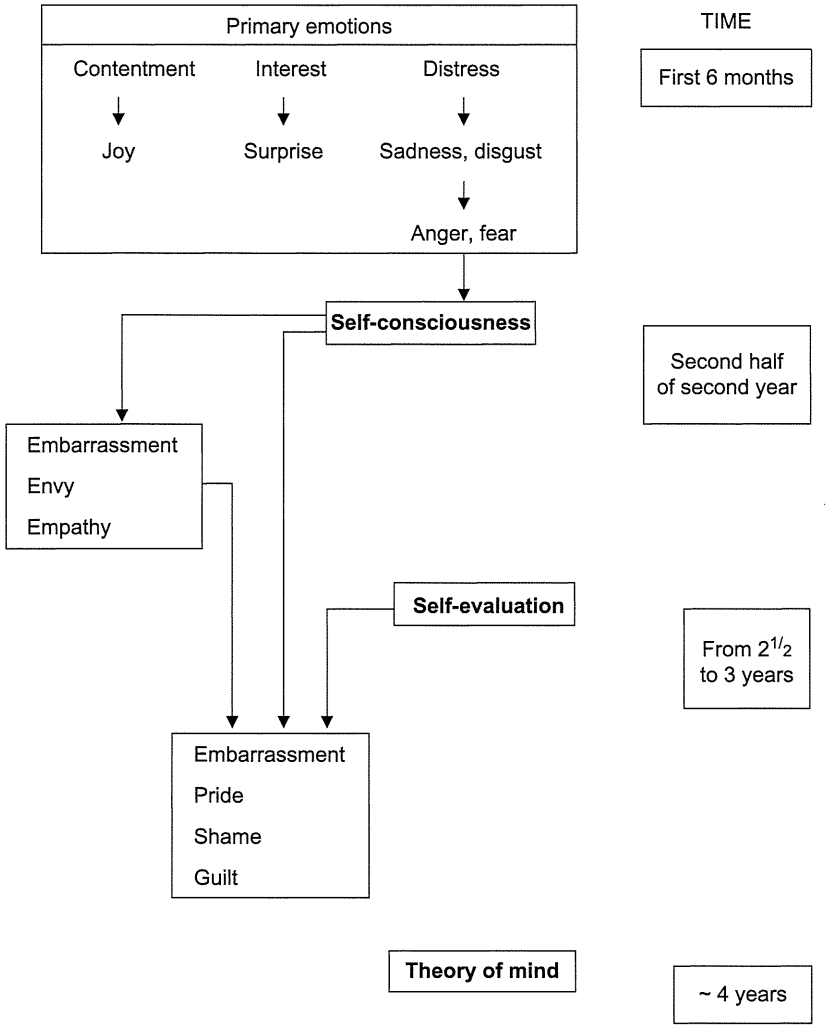


FIGURE 33.1 Development process of self-awareness of infants. *Compiled from Lewis's developmental model of cognition and emotion, and Wimmer's and Perner's theory of mind.*

TABLE 33.1 Model for Interpreting Puzzling Words and Deeds of Dementia Patients from the Viewpoint of Self-Awareness

Theory of Mind

When the function of "theory of mind," which is the ability to infer psychological states (intention, thought, belief, desire, emotion, etc.) that are in the background of the behavior of the self and others and cannot be directly observed, is lost, one becomes unable to understand the intentions, thoughts, and so on, of the self and others.

Self-Evaluation

When the function of "self-evaluation" is lost, one becomes unable to evaluate conditions of the self. Furthermore, emotions of "guilt," "shame," and "pride" are lost, and one becomes able to act against society's rules and standards without hesitation.

Self-Consciousness

When the function of "self-consciousness" is lost and the psychological distinction between the self and others is gone, the emotion of "empathy," which is the basis of human relations, is lost and one becomes able to act only based on primary emotions ("fear," "anger," "disgust," "sadness," "surprise," "joy," "distress," "interest," and "contentment").

they live, acquire a "self-evaluation" function that judges whether their own thoughts, emotions, and deeds are good or bad by comparing them against the rules and standards of their society, and the self-conscious evaluative emotions "shame" and "guilt" develop. When children reach 4 years of age, they begin to acquire a "theory of mind," which is the ability to infer the mental states (intention, thought, belief, desire, emotion, etc.) in the background of their own and others' behavior that cannot be directly observed. Expressed in another way, infants become aware of their own existence as a result of the emergence of "self-consciousness," distinguish between themselves and others, begin to prepare to adapt to the rules of the society in which they live as a result of "self-evaluation," infer their own and others' minds by the "theory of mind," and adapt to interpersonal relations with an unspecified number of other people. In other words, the development of self-awareness is the foundation on which infants adapt to complex interpersonal relations.

In our self-awareness model, we evaluate the presence of "theory of mind," "self-evaluation," and "self-consciousness" by the methods described below.

Evaluation for the Presence of "Theory of Mind"

The evaluator and the subject sit at a table facing each other, and the evaluator shows four picture cards illustrating Perner et al.'s "false-belief task" [21] originally drawn by Muto [28] and later modified by us in a way that is easier to understand (Figure 33.2). After checking to be sure that the subject's attention is directed at the cards, while pointing at the card with a finger, the evaluator carefully explains the content of each of the scenes shown in Figure 33.2. Whenever the reply is vague, the evaluator repeats the explanation. If a subject's reply is "the round box" by inferring the mind of Taro, it is concluded that "theory of mind" is present.

Evaluation for the Presence of "Self-Evaluation"

The evaluator and the subject sit at a table facing each other, and the evaluator shows the subject four sets of picture cards, one set at a time, that we prepared to evaluate understanding of basic rules and standards of Japanese society (Figure 33.3). After checking to be sure that the subject's attention is directed at the cards, the evaluator carefully explains the content of

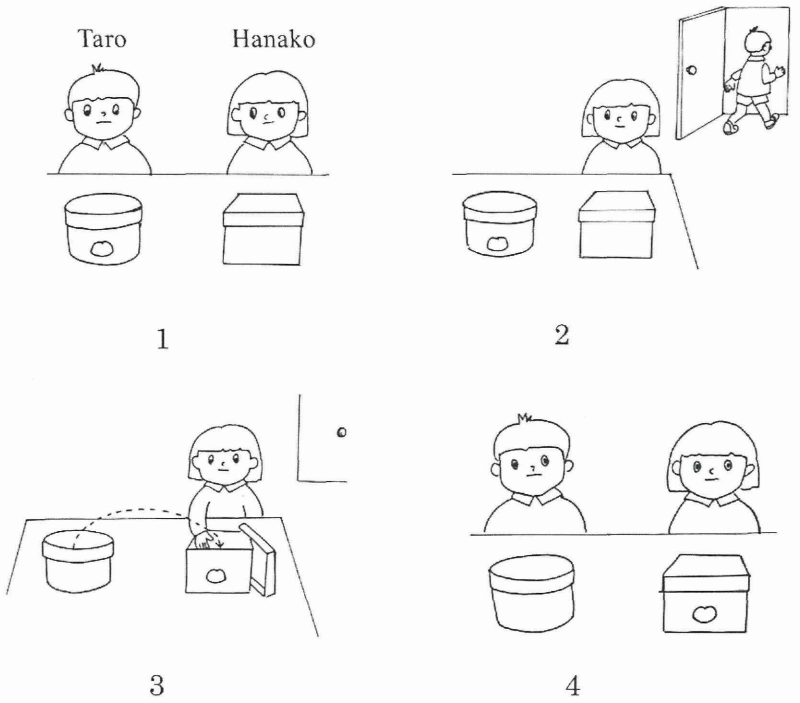


FIGURE 33.2 Evaluation for the presence of theory of mind.
Scene 1. "There are a round box and a square box in front of Taro and Hanako. A bean-jam bun is contained in the round box."
Scene 2. "Taro is leaving the room."
Scene 3. "In the meantime, Hanako has transferred the bean-jam bun from the round box to the square box."
Scene 4. "Taro has come back. In which box, the round box or the square box, does Taro think the bean-jam bun is in?"

the picture cards. We put the name of the subject in the XXX, and when the subject is a woman, cards showing the same scenes in which a picture of a female has been drawn are used. Whenever the reply is vague, the evaluator repeats the explanation. When the replies to all four tasks are correct, it is concluded that "self-evaluation" is present.

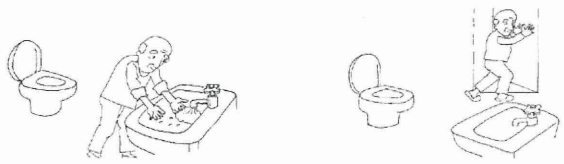
Because according to Lewis, "self-evaluation" ability is acquired at 2.5–3 years of age, using similar picture cards with children as models, we confirmed in advance that the tasks were appropriate for nursery school children as subjects, so that the great majority of children from 2 years 11 months of age onward would be able to pass.

Evaluation for the Presence of "Self-Consciousness"

The name of the subject (family name and first name), which is the core of the perception of self and others, and a symbol indicating the actual existence of each person [29], the name of someone else, and the meaningless sound "a–h" is uttered from behind the subject, and the subject is checked for a reply or looking back. When the response is vague, the procedure is repeated. When the subject replies or looks back in response to the subject's name alone, "self-consciousness" is concluded to be present.

THE PUZZLING EATING BEHAVIOR OF DEMENTIA PATIENTS SEEN FROM THE VIEWPOINT OF THE SELF-AWARENESS MODEL

Alzheimer's disease patients who exhibit the mirror sign by speaking to mirrors unable to recognize their image reflected in the mirror as their own image, sometimes use a mirror to wash the face, fix the hair, shave, etc. [30,31]. Thus, the nature of dementia cannot be appreciated without observing scenes of dementia patients' actual daily lives.



Task 1

Task 2

Task 3

Task 4

FIGURE 33.3 Evaluation for the presence of self-evaluation.
Task 1. "Mr. XXX is washing his hands after using the toilet," and "Mr. XXX does not wash his hands after using the toilet." Which is better?
Task 2. "Mr. XXX is quarreling with his friend," and "Mr. XXX is getting along well with his friend." Which is better?
Task 3. "Mr. XXX is wearing his clothes in public," and "Mr. XXX has not put his clothes on and is naked in front of everybody." Which is better?
Task 4. "Mr. XXX is eating while standing," and "Mr. XXX is eating while sitting." Which is better?

TABLE 33.2 Typical Meal Scenes Observed in This Stage

1. After eating, the patient put the tray out in front of the patient.
2. The patient used a plate held in the patient's hand to catch food that spilled out of the patient's mouth.
3. The patient picked up rice that fell on the patient's leg with a hand and put it back in the bowl without eating it.
4. When the caregiver asked: "Aren't you going to eat any more?," the patient became angry.
5. When a patient with severe dementia sitting at the same table tapped on the table, the patient warned the other patient in a strong tone: "Tap on your own head" (the patient did not realize that the other patient was a patient with severe dementia).

We therefore show meal scenes that are characteristic of each stage of self-awareness—primarily data we obtained from observations of the meals of dementia patients admitted to institutions [26], and explain their puzzling eating behavior on the basis of the self-awareness model.

Moreover, because their language is closely related to their self-awareness, we also show the circumstances of their conversations at each of the stages.

In addition, we also recorded the patients' Clinical Dementia Rating (CDR) in the beginning of each stage in order to be able to make comparisons between the individual stages of self-awareness and the degrees of severity of common dementias [32].

Stage in Which Patients Passed the "Theory of Mind" Task CDR: Mild–Moderate

Because patients with the mild–moderate stage of dementia observe the rules of society and are able to infer their own mind and the mind of others, no puzzling eating behavior is seen.

Stage in Which Patients Passed the "Self-Evaluation" Task but Failed the "Theory of Mind" Task CDR: Moderate–Severe

Patients with moderate–severe stage dementia repeat the same content in conversations with other people, and the content of their speech does not develop very much. They are aware of their own diminishing intelligence and say such things as, "Because I'm stupid."

Typical meal scenes observed in this stage are described in Table 33.2.

As shown by dementia patients saying "Because I'm stupid" at this stage, dementia patients in the meal scenes recognized the decrease in their own intelligence, were aware of the circumstances of their own eating behavior, and were able to evaluate their own behavior by comparing it against social standards (meal scenes [1], [2], and [3]). Thus, because patients are able to adhere to society's rules, hardly any words or deeds that caregivers cannot approve are observed in the meal scenes up to this stage.

However, egocentric words and deeds (meal scenes [4] and [5]) are sometimes observed. This shows that when patients can no longer pass the "theory of mind" task, their understanding of their own and others' minds becomes vague, and egocentrism in the sense that the developmental psychologist Piaget [33] describes as not being able to put oneself in another's place is seen.

Stage in Which Patients Passed the "Self-Consciousness" Task but Failed the "Self-Evaluation" Task CDR: Severe

There is little verbal expression, and its content lacks coherence.

Typical meal scenes observed in this stage are described in Table 33.3.

When patients are no longer able to pass the "self-evaluation" task, their awareness of their circumstances becomes vague, and they are no longer able to evaluate their own behavior by comparing it against society's standards. They also lose the self-conscious evaluative emotion of shame. This is often manifested by an inability to be concerned about spilled food (meal scene [1]), not removing rice grains that have stuck to their chin (meal scene [2]), behavior with no concern for what others think (meal scene [3]), and suddenly slapping the hand of a caregiver who is trying to feed them (meal scene [4]). In addition, there is a function that exercises control over emotions in words, but because they almost completely lose language from this stage onward, sudden violent behavior occurs (meal scene [4]).

If patients lose the ability to place their viewpoint out of the "present" time frame and become unable to look back at themselves, their time consciousness disappears [34]. In short, when patients are no longer able to introspect on themselves and evaluate themselves, they can no longer stand outside the present, and the past and the future do not exist. Dementia

TABLE 33.3 Typical Meal Scenes Observed in This Stage

1. Food spilled during the meal, but there was no evidence that the patient was concerned about it.
2. The patient did not try to remove the rice grains that stuck to the patient's chin.
3. Behavior with no concern about what others think, such as picking up food that had spilled and eating it, licking the plate after finishing eating, was seen.
4. When the caregiver tried to take the dementia patient's spoon in order to feed the patient because the meal had not progressed, the patient suddenly slapped the caregiver's hand.
5. The patient was unable to sit at the dining table, and a little while later walked away somewhere.

TABLE 33.4 Typical Meal Scenes Observed in This Stage

1. Retained food in the mouth and did not swallow it.
2. Held the spoon up to the mouth and touched the lips with it, but did not open the mouth
3. Did not look at the food in front of the patient or at food that had spilled.
4. Never ate until spoken to.
5. Put an object such as a moist towelette, towel, or apron into the mouth and was gnawing on it.

patients in this stage, in which they have lost time consciousness, also represent various scenes, but they cannot be positioned in time. In order to perform purposeful behavior, it is necessary to represent the future, which is the result of the behavior. There is no purpose in behavior in which dementia patients who are unable to represent the future walk away somewhere during a meal (meal scene [5]).

Stage in Which Patients Fail to Pass the "Self-Consciousness" Task CDR: Severe

Hardly any verbal expression is heard.

Typical meal scenes observed in this stage are described in Table 33.4.

Behavior in which patients retain food in their mouth and do not swallow it (meal scene [1]) makes prolonged meal assistance necessary, and it makes it very difficult for the caregiver. Why do we swallow food in our mouth in the first place? Do we automatically swallow whenever we chew? Do we swallow food in our mouth to be able to eat the next portion of food? If we are conscious of it during a meal, we are aware of it, and we swallow the food in our mouth in order to eat the next portion of food. In brief, the reason for not swallowing food in our mouth is a decrease or loss of independence. The subject came into being with the birth of "self-consciousness," and independence developed. Expressed in another way, independence disappears as "self-consciousness" is lost. As well as behavior in which food is retained in the mouth and not swallowed (meal scene [1]), touching the lips with the spoon but not opening the mouth (meal scene [2]), not looking at the food in front of one or at spilled food (meal scene [3]), and never eating until spoken to (meal scene [4]) show that independence decreased and was lost as "self-consciousness" was lost.

When we are no longer capable of introspecting on and evaluating our own circumstances, we do not know where we are or what we are doing there. Because we are able to introspect on our circumstances and evaluate ourselves, we do not put things other than food into our mouth. There is nothing strange about the behavior of putting things into our mouth from a survival standpoint. In other words, it is because of not being able to introspect on their own circumstances and evaluate themselves that dementia patients put objects such as moist towelettes, towels, or aprons in their mouth (meal scene [5]).

Moreover, when we lose self-consciousness, the psychological boundary between self and non-self becomes vague, and the self as a subject that protects the self as an object breaks down. As a result, life-sustaining functions decrease dramatically, and the risk of putting things other than food into our mouth and swallowing them increases.

"FRAGILE SELVES" THAT COLLAPSE WITH LOSS OF "SELF-AWARENESS"

The phenomenon of no infant memories remaining is called "infantile amnesia," and the cause is thought to be that self-awareness has not developed [35]. If self-awareness does not develop, my experiences will not become my memories. Episodic memories and semantic memories, which rise into consciousness, and even procedural memories, which do not rise into consciousness, are also my experiences that, in the beginning, are mediated by self-awareness. These memories via my experiences have produced my self. However, the self that the network of neurons in my brain created through my

experiences may actually be surprisingly fragile. There is an illusion called the "rubber hands illusion" [36]. In this illusion, the subject places a hand on a desk behind an object so that the subject cannot see it and then places a false hand made of rubber, etc., on the desk in full view, and when the subject's own hand and the false hand are synchronously stroked, the false hand is felt as though it were the subject's own hand.

This fragile self, which has been produced through self-awareness, collapses together with the loss of self-awareness.

APPLICATIONS TO OTHER DEMENTIAS

Dementia is a condition in which intelligence as a whole decreases. If we explain the puzzling words and deeds of dementia patients on the basis of individual cognitive impairments (amnesia, apraxia, agnosia, apathy, attentional disorder, affective disorder, impaired judgment, etc.), then the interpretations that exist for their puzzling behavior are multiplications of combinations of amnesia, apraxia, agnosia, apathy, attentional disorder, affective disorder, impaired judgment, etc. Moreover, memory, for example, is classified according to form into episodic memory, semantic memory, procedural memory, etc., and according to time into immediate memory, recent memory, and remote memory. In addition, the severity of memory disorders is classified into mild, moderate, severe, etc. When they are added to the multiplication factors, an unlimited number of combinations ultimately exists, and combinations of interpretations for the puzzling behavior of dementia patients become limitless. In the final analysis, it must be interpreted on the basis of an unlimited number of mental functions. By taking an approach that is based on an unlimited number of mental functions, a universality capable of interpreting the puzzling behavior exhibited by patients with a variety of dementing diseases comes into being for the first time. In this article, these unlimited mental functions are self-awareness.

By making an interpretation on the basis of self-awareness, the picture of dementia patients who cannot adapt to complex interpersonal relationships comes into focus. People find happiness in interpersonal relations. If not approached on the basis of self-awareness, which is the foundation of interpersonal relations, dementia patients and their caregivers will not be able to restore interpersonal relations, and dementia patients will be incapable of receiving support to live happily.

PRACTICAL ISSUES

Determining how to apply the self-awareness model to dementia care is a future task.

The purpose of dementia care is to improve the quality of life (QOL) of dementia patients and their caregivers. Expressed in another way, the purpose of dementia care is for patients and caregivers to be freed from the behavioral and psychological symptoms of dementia (BPSD) and live calmly.

Caregivers know well that if warned, given logical explanations, or asked to do things they are incapable of doing, dementia patients become confused, and BSPD appear. On the other hand, caregivers also know well that dementia patients become calm in an environment where there are gentle voices and hands, carefully prepared foods, quiet music, a gentle breeze on their cheeks, warm sunlight bathing their faces, and beautiful flowers. When self-awareness decreases, patients become unable to position themselves in time and space. The result is that their self is unable to live in the "there and then" world and is only able to live in the "here and now" world. This function that transcends space-time is an operation of representation. Because language, which is a code, is based on representations, when the representation function decreases, language function naturally also decreases. In brief, the key point in the care of dementia patients, who live in the "here and now" world, is not approaching their cognitive functions, such as memory, which is reminded by language, or the ability to make judgments, etc., which is a language operation, but approaching self-awareness through the five senses, which do not necessarily transcend space-time.

The same is also true of intervention. Non-pharmacological intervention, including reminiscence therapy, validation therapy, and music therapy, have not been shown to be effective against BPSD [37–39]. It is also unlikely that intervention once a week would maintain its effect in dementia patients who have a memory disorder. There is a very interesting attempt to continually stimulate the self-awareness of female dementia patients: manicure (nail polish) therapy [40]. Nail polish can be easily applied by anyone. It takes about 10 days for the color to wear off after putting on nail polish, and it requires hardly any manpower. Moreover, the fingers are usually visible on tables in a variety of settings, such as during meals, and to dementia patients who have memory disorders, the manicures are always fresh. The authors have also observed scenes in which elderly female dementia patients were given a manicure, and their lively femininity was beautifully expressed. Taking a hint from manicure therapy, we have begun a study of ring therapy [41].

The approach to self-awareness has opened up new avenues of dementia care.

DEMENTIA PATIENTS' NUTRITION

As self-consciousness decreases, the time comes when prevention of aspiration pneumonia and artificial nutrition and hydration management are necessary. Gastrostomies are currently being performed for long-term nutrition management.

In Western countries, there is generally thought to be no medical basis for gastrogavage as a means of improving life expectancy, preventing aspiration pneumonia, or improving the QOL of dementia patients [42–45]. By contrast, in recent years, a large-scale survey in Japan, where super-aging of the population has been progressing and a universal health care insurance system and nursing-care insurance system unparalleled anywhere in the world have been set up [46], showed that gastric fistulas were effective in terms of life expectancy. That was the result of a survey of 1,168 dementia patients in whom gastric fistulas were created at 46 medical institutions. Of the 931 patients whose survival data could be analyzed, 99%, 95%, 88%, 75%, and 66% were found to have survived 7 days, 30 days, 60 days, 6 months, and 1 year or more, respectively. The results also showed that 50% had survived 753 days and 25% had survived 1,647 days or more. These results differed considerably from the results obtained in Western countries. The reason for the differences may be differences in the timing of the gastrostomy, in other words, differences among the patients who were the subjects. The reason may also have been differences in medical treatment or care after the gastrostomy. In short, in Japan, public health care insurance ensures good health care after the gastrostomy as well. Moreover, as a result of the nursing-care insurance system that began in 2000, even dementia patients whose gastric fistula is managed at home receive daily home-visit nursing, home-visit nursing care, etc., and during the day they make visits to institutions, and their condition is managed there. Furthermore, after the inauguration of the nursing-care insurance system, awareness of aspiration pneumonia and oral care by nurses and nursing-care workers, as well as by speech therapists increased, and patients with a gastrostomy are receiving oral care both at home and in institutions. Thinking about gastric fistulas for dementia patients varies from country to country because of differences in views of life and death, but it seems necessary to take a fresh look at the effectiveness of gastrogavage.

SUMMARY POINTS

- Because dementia is an overall decrease in intelligence, the puzzling eating behavior of dementia patients cannot be explained on the basis of individual cognitive impairments alone.
- Approaching it on the basis of intelligence and mind as a whole is needed.
- We have therefore explained the puzzling eating behavior of dementia patients by means of our self-awareness model (composed of "theory of mind," "self-evaluation," and "self-consciousness"), which views intelligence and mind as a whole in the form of self-awareness.
- We have described a key point in regard to care and a method of continually stimulating the self-awareness of dementia patients.
- Last, we have reported the results of a large-scale survey in Japan of the effectiveness of gastrogavage for dementia patients and pointed out differences from Western countries.

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Feasibility and efficacy of speed-feedback therapy with a bicycle ergometer on cognitive function in elderly cancer patients in Japan

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Abstract

***Objective*: We conducted this study with the aim of demonstrating the feasibility and efficacy of speed-feedback therapy with a bicycle ergometer on cognitive function in elderly cancer patients.**

***Methods*: The subjects were patients with breast or prostate cancer who were 65 years of age or over. Among 146 patients, 78 were randomly assigned to the intervention group ($n = 38$) or the control group ($n = 40$). The intervention group received speed-feedback therapy with a bicycle ergometer once a week for four successive weeks. The control group was advised to spend the 4-week period engaged in their routine activities. Evaluations were carried out at the baseline and 4 weeks after the baseline (week 4) using the Frontal Assessment Battery, the Barthel Index, the Lawton and Brody Instrumental Activities of Daily Living, and the Functional Assessment of Cancer Therapy-General ver.4. Data were analyzed by a two-way repeated-measures analysis of variance.**

***Results*: The mean score of Frontal Assessment Battery for the intervention group was higher than that for the control group at week 4. In addition to significant main effects of time and group, we also found a significant interaction between the two groups ($p = 0.006$). Moreover, all of the subjects in the intervention group could complete all the four sessions of therapy without any pain or distress.**

***Conclusion*: These results suggest that speed-feedback therapy with a bicycle ergometer may be feasible as well as effective for improving the cognitive function in elderly cancer patients.**

Introduction

Existence of an association between cancer therapy and cognitive decline has been pointed out since the early 1990s. Recent surveys have revealed cognitive decline in 25–50% of elderly cancer patients, with the proportion of patients with cognitive decline increasing with age [1,2]. There are some reports indicating the possible factors that influence on the cognitive function in elderly cancer patients, such as aging, cancer itself [3], chemotherapy [4–6], and hormone therapy [7,8]; however, there is still ongoing debate about the influence of cancer treatments on cognitive functions [9,10]. Although no conclusive evidence has been collected regarding increased vulnerability of elderly cancer patients to cognitive functional decline, it is thought that a number of factors, including the age, the cancer itself, and various cancer treatments, may covertly or overtly affect the cognitive functions in elderly cancer patients.

Because the cognitive ability of the elderly has been reported to not only affect the decision-making abilities required to select appropriate treatment but also have an influence on the affective state, ability to perform activities of daily living and quality of life (QOL) of the patients [11], it is extremely important to strive to maintain and improve the cognitive functions in elderly cancer patients. However, there have been scarcely any reports on the rehabilitation practices in relation to cognitive decline for elderly cancer patients [12], and few studies have been designed to evaluate the effect of interventions to treat cognitive decline [13]. Thus, examination of the efficacy of rehabilitation focused on improving the cognitive decline in elderly cancer patients is an important issue [14].

In the present study, we attempted to assess the efficacy of speed-feedback therapy with a bicycle ergometer as a rehabilitation approach aimed at improving the cognitive function of elderly cancer patients. Speed-feedback therapy with a bicycle ergometer is a rehabilitation approach designed to improve the cognitive functions [15], and it has already been reported to be effective in improving the cognitive function of dementia patients; its safety even in the elderly has also been confirmed [15,16]. If the feasibility and efficacy of this therapy as a rehabilitation intervention could be demonstrated in this study, clinical application of this method for the rehabilitation of elderly cancer patients would become possible in the future, which would not only contribute to the expansion of rehabilitation in this field, but provide important suggestions in regard to the support required for maintaining a higher QOL for elderly cancer patients suffering from cognitive decline.

Methods

Study design

This study was a 4-week randomized controlled trial comparing the effects of rehabilitation by speed-feedback therapy using a bicycle ergometer (intervention group) with those of routine life activities without any rehabilitation intervention (control group). Eligible patients were randomized at a 1:1 ratio to the intervention group or the control group by the researcher in charge of the allocation using the envelope method. Patients and therapists were, however, informed about the group allocations. An independent evaluator who assessed the outcome by comparing the parameters at baseline and week 4 was masked to the assignment condition throughout the trial. The study was conducted from October 1, 2011 to May 10, 2012.

Participants

Breast cancer or prostate cancer patients attending the outpatient clinic of Hiroshima University Hospital who were 65 years of age or over at the time of provision of informed consent for participation, whose performance status was 0 or 1, and who were capable of walking unassisted were enrolled as the subjects of this study. The reason to select breast and prostate cancer patients as the participants was that there are many common characteristics between breast and prostate cancer patients, including the beneficial effects of sex hormones, slow progression and tendency to retain functional status, increasing morbidity in Japan, the possibility of treatment selection (operation, chemotherapy, hormone therapy, and radiotherapy), and previous reports of an association with cognitive decline. Patients who had bone-metastasis, had received whole-brain irradiation, required medical risk factor management for cardiorespiratory disease, or whose ability to pedal the ergometer was impeded by an orthopedic disease, or central nervous system paralysis were excluded from the study.

Intervention method

We conducted speed-feedback therapy with a bicycle ergometer for the intervention group at the rehabilitation room of Hiroshima University Hospital. It is a rehabilitation approach designed to improve the cognitive functions, involving the use of a training machine consisting of a bicycle ergometer connected to a PC. The subjects were instructed to pedal the bicycle ergometer to match the target speed arbitrarily displayed on the PC screen. A standard path corresponding to the target number of revolutions is displayed on the screen (standard number of revolutions), and the subject pedals the ergometer while visually tracking and paying attention so as to follow the path (Figure 1). The actual path pedaled by the subject (actual number of

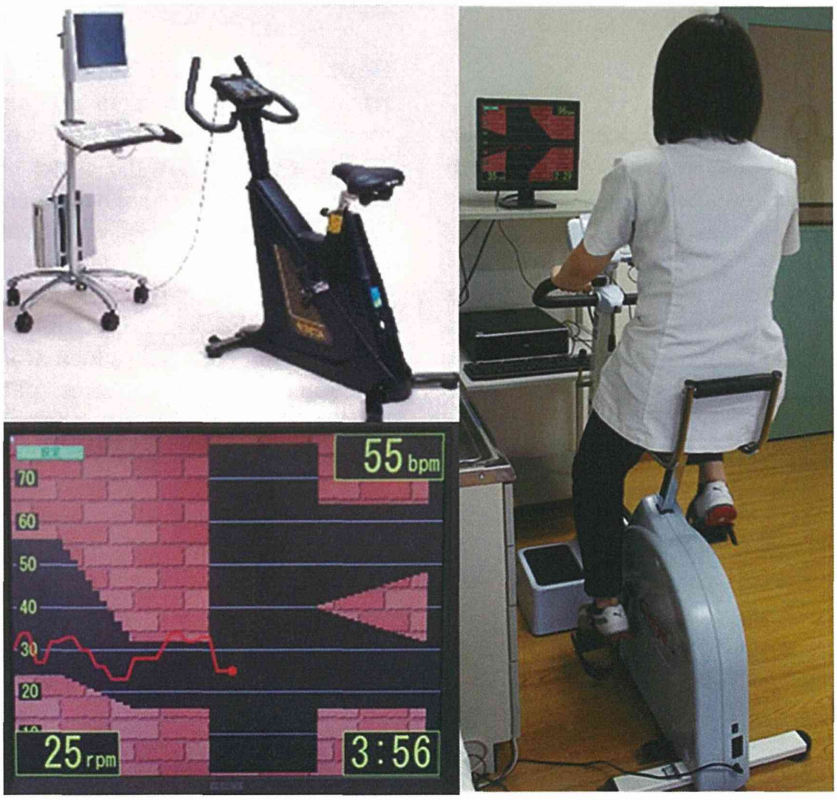

Figure 1. Speed-feedback therapy with a bicycle ergometer

revolutions) is displayed in real time, with the standard path changing constantly. The efficacy of this therapy in improving cognitive impairment in elderly people has been reported previously [15,16]. For this study, we set the exercise load at 20 W and the maximal number of rotations at 80 rpm, and the pedaling time at 5 min based on our previous studies [15,16]. A total of four sessions of the exercise program was undertaken over 4 weeks, at the frequency of one session per week. The subjects' vital signs and health status were checked before, during, and after the program by the therapists. On the other hand, we requested the control group to spend the 4-week period engaged in their routine activities.

Assessment

We investigated the age, gender, number of years of education, employment status, exercise habit, site of the primary cancer lesion, date of diagnosis, stage of cancer, treatment history, and ongoing treatment as sociomedical parameters. We used the Frontal Assessment Battery (FAB), which was developed as a short bedside cognitive and behavioral battery to assess the frontal lobe functions and consists of six domains: (1) similarities (conceptualization), (2) lexical fluency (mental flexibility), (3) Luria motor sequences (programming), (4) conflicting instructions (sensitivity to interference), (5) a go-no go test (inhibitory control), and (6) comprehension behavior (environmental autonomy) [17]. The reliability and validity of the Japanese version of FAB for dementia has previously been confirmed [18]. FAB has been reported to be useful as a cognitive evaluation instrument for measuring the cognitive function of elderly cancer patients [19]. In our previous study, we confirmed the FAB, as compared with other scales such as the Mini-Mental State Examination [19], as a highly useful tool for evaluating the cognitive function in elderly cancer patients. The Barthel Index (BI) [20] and Lawton and Brody Instrumental Activities of Daily Living (IADL) [21] were used to evaluate the activities of daily living, and the Functional Assessment of Cancer Therapy-General ver.4 (FACT-G) [22] was used as the QOL scale. We were granted license by FACIT.org to use the Japanese version of FACT-G for this study. The assessments were carried out at the baseline and immediately after the fourth intervention session for the intervention group, and 4 weeks after the baseline for control group (week 4), by an independent evaluator who was masked to the assignment condition throughout the trial.

Sample size

Using previous studies as reference [16,19], we calculated the sample size that would be required to obtain results with a statistical power of 80% for a two-tailed test (5% significance level) based on an efficacy rate (change in FAB score from the baseline to completion of therapy) of 10% (2 points) and standard deviation of 2.6 in the intervention group, and determined that 28 patients per group would be required. Assuming a dropout rate of 10%, we decided to enroll 31 patients per group, that is, a total of 62 patients.

Statistical analysis

Descriptive statistical analysis was performed in regard to the subjects' background characteristics and scores on each of the scales in order to obtain an overview of the subjects as a whole at the baseline. Next, the Mann–Whitney *U*-test was used to analyze continuous variables after performing the Kolmogorov–Smirnov test of normality and the chi-squared test or Fisher exact test for analysis of the categorical data such as the background factors of the subjects at baseline and their scores on each of the evaluation scales, as appropriate. Then, we performed a two-way repeated-measures analysis of variance (ANOVA) by using the scores on each of the evaluation scales as the dependent variables in order to assess differences in the changes of the scores on each of the evaluation scales between the baseline and completion of the intervention (week 4) between the two groups. We finally investigated the independent factors that might affect the changes of the FAB score by using stepwise multiple regression analysis. The analysis included all baseline factors except the primary cancer site, which was coincident with gender, as explanatory variables (Table 1). The p values in all of the tests were two-sided, and $p < 0.05$ was considered to denote significance. All of the statistical analyses were performed using the IBM SPSS 21.0 Statistics (IBM Japan, Tokyo, Japan).

Ethical considerations

This study was conducted in compliance with the Declaration of Helsinki adopted by the World Medical Association and the Ethical Guidelines for Clinical Research of the Japanese Ministry of Health, Education and Labor; prior approval for conduct of the study was obtained from the Clinical Research Ethics Committee of Hiroshima University.

Results

Summary of the circumstances of the subjects' participation

The circumstances of the subjects' participation are summarized in Figure 2. Informed consent for participation in this study was obtained from 78 of the 146 patients who met the eligibility criteria. Random assignment of these 78 subjects resulted in 38 subjects being allocated to the intervention group and 40 subjects being allocated to the control group. Because there were no dropouts from either of the groups, all of the 78 subjects were included in

Table 1. Comparison between the groups at the baseline

		Intervention ($n = 38$)	Control ($n = 40$)	p value[a]
Mean age (years: SD)	Years (SD)	72.97(4.57)	75.45(6.57)	0.15
Gender	Male (%)	17(44.7)	18(45.0)	0.98
	Female (%)	21(55.3)	22(55.0)	
Years of education	Mean years (SD)	12.03(2.05)	12.20(3.27)	0.54
Employed	Yes (%)	8(21.1)	11(27.5)	0.51
	No (%)	30(78.9)	29(72.5)	
Exercise habit	Less than once a week (%)	18(47.4)	24(60.0)	0.26
	More than once a week (%)	20(52.6)	16(40.0)	
Primary cancer site	Breast (%)	21(55.3)	22(55.0)	0.98
	Prostate (%)	17(44.7)	18(45.0)	
Time since the diagnosis	Mean months (SD)	56.57(32.52)	68.88(54.77)	0.68
Stage of cancer	Stage I (%)	11(28.9)	13(32.5)	0.51
	Stage II (%)	22(57.9)	15(37.5)	
	Stage III (%)	1(2.6)	5(12.5)	
	Stage IV (%)	4(10.5)	7(17.5)	
Treatment history[b]	Operation (%)	31(81.6)	29(72.5)	0.34
	Chemotherapy (%)	9(23.7)	11(27.5)	0.70
	Hormone therapy (%)	26(68.4)	32(80.0)	0.24
	Radiation therapy (%)	26(68.4)	16(40.0)	0.01
Ongoing treatment	Chemotherapy (%)	1(2.6)	4(10.0)	0.36
	Hormone therapy (%)	18(47.4)	23(57.5)	0.37
	Radiation therapy (%)	1(2.6)	1(2.5)	1.00
FAB	Mean score (SD)	15.0(1.59)	14.50(1.87)	0.15
BI		100.0(0)	99.75(1.58)	0.33
IADL		9.55(1.08)	9.15(1.53)	0.08
FACT-G		75.29(15.76)	74.30(14.27)	0.75

SD, standard deviation; FAB, Frontal Assessment Battery; BI, Barthel Index; IADL: Instrumental Activities of Daily Living; FACT-G, Functional Assessment of Cancer Therapy-General (ver.4).

[a]Chi-squared-tests or Fisher exacts test were used for categorical data, as appropriate. Mann–Whitney *U*-tests were used for continuous variables.

[b]There were multiple answers.

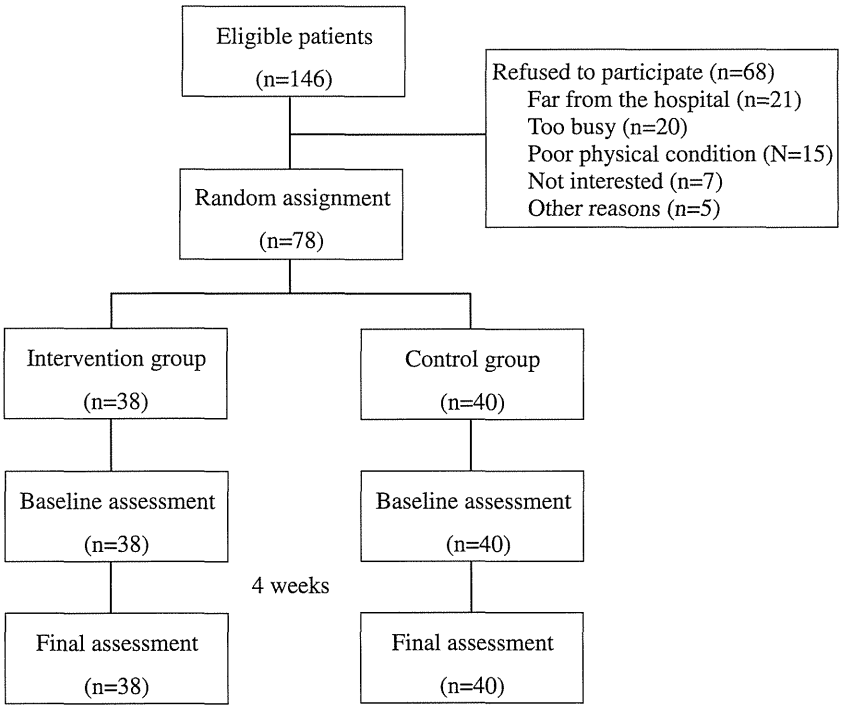

Figure 2. Flow of participants through the trial

the evaluations. No subjects in the intervention group had any trouble with the use of the bicycle during the speed-feedback therapy using a bicycle ergometer. Moreover, the heart rate criterion for stopping the exercise was not exceeded in any of the patients during the conduct of the therapy sessions nor was there any abnormal changes of the blood pressure in any of the patients either before or after the therapy; none of the patients complained of any pain or distress.

Comparison of the characteristics between the intervention group and the control group at baseline

At the baseline, there were no significant differences in the age, gender, years of education, employment status, exercise habit, primary cancer site, time since diagnosis, stage of cancer, treatment history, except radiation therapy, ongoing therapy, or total or subscale scores on any of the evaluation scales between the intervention group and the control group (Table 1). However, there was one significant difference ($p=0.01$) between the two groups, related to the history of treatment: the proportion of patients who had received radiation therapy was higher in the intervention group than that in the control group (there were multiple answers).

Comparison of the changes in the scores on each of the scales between the intervention group and the control group

In all scales we evaluated, the mean score for the intervention group tended to be higher than that for the control group at both baseline and week 4. In all scales but BI, the mean score at week 4 tended to be higher than that at baseline for both intervention and control groups (Table 2). As a result, two-way ANOVA revealed a significant time effect ($F=24.39$, $p<0.001$, partial $\eta^2=0.247$) and a significant group effect ($F=9.26$, $p=0.003$, partial $\eta^2=0.109$) only on the FAB score, and not on other scales. In addition to two main effects, we also found a significant interaction between the two groups only on the FAB score ($F=7.88$, $p=0.006$, partial $\eta^2=0.094$) (Figure 3).

Independent factors affecting the changes in the FAB score

At the baseline, we observed a significantly higher proportion of patients with a previous history of radiation therapy in the intervention group as compared with that in the control group. To exclude the possibility of this finding affecting the results of our analysis, we evaluated the changes in the FAB scores according to previous radiation therapy and intervention. In patients with previous radiation therapy, the mean changes of the FAB scores were 1.50 (standard deviation (SD) = 1.55) and 0.75 (SD = 1.82) in the intervention and control groups, respectively. In patients without previous radiation therapy, on the other hand, the mean changes of the FAB scores were 1.83 (SD = 0.99) and 0.25 (SD = 2.24) in the intervention and control groups, respectively. From these results, it was concluded that previous radiation therapy was unlikely to have been a confounding factor causing potential overestimation of the effect of the intervention on the FAB scores. Furthermore, we reevaluated the effect of our intervention on the changes of the FAB scores by stepwise multiple regression analysis, including all the baseline factors, except for the primary cancer site, which was coincident with the gender (Table 1). After adjusting for potential confounding factors, the intervention remained an independent factor influencing the changes in the FAB scores ($p=0.030$, beta = 0.241). In

Table 2. Baseline and week 4 scores on outcome measures

	Intervention	Control	Interaction		Main effect			
	($n=38$)	($n=40$)	group × time		Time		Group	
	Mean (SD)		*F*	*p* value	*F*	*p* value	*F*	*p* value
FAB			7.88	0.006	24.93	<0.001	9.26	0.003
Baseline	15.00(1.59)	14.50(1.87)						
Week 4	16.61(1.37)	14.95(2.25)						
BI							0.95	0.333
Baseline	100.00(0)	99.75(1.58)						
Week 4	100.00(0)	99.75(1.58)						
IADL			0.07	0.789	1.96	0.165	2.83	0.097
Baseline	9.55(1.08)	9.15(1.53)						
Week 4	9.74(0.80)	9.28(1.38)						
FACT-G			0.11	0.738	1.10	0.297	0.26	0.612
Baseline	75.29(15.76)	74.30(14.27)						
Week 4	77.47(14.01)	75.42(15.42)						

SD, standard deviation.

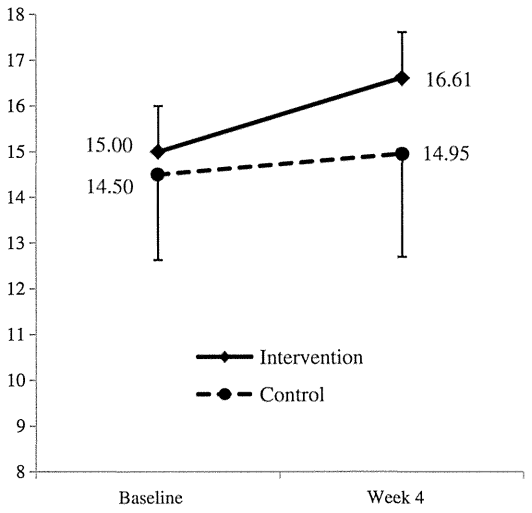

Figure 3. Change between the two groups in Frontal Assessment Batteryn (FAB) scores

addition, we found age as another independent factor ($p = 0.018$, beta $= -0.264$).We found no significant effect of the stage of cancer or the treatment regimen employed on the changes of the FAB scores.

Discussion

Circumstances of the conduct of speed-feedback therapy with a bicycle ergometer

During the conduct of the program, there were no dropouts from the intervention group for any reason, either refusal to participate or deterioration of the subject's condition after the start of the program, and all of the four sessions could be completed in all of the subjects. Also, many positive comments, such as "it was fun, like a game" were heard from the participants. Therefore, we believe that the program is highly feasible. Furthermore, all of the subjects of the intervention group were able to accomplish the program without any abnormal changes of physical condition either before or after the speed-feedback therapy, and none of the patients complained of any pain or distress. The former findings reveal that the speed-feedback therapy with a bicycle ergometer undertaken in this study was associated with very little risk of adverse events, even when applied to elderly cancer patients, and that it is a safe program.

In addition, we found that there are many cancer patients in Japan who continue to live with an uneasy feeling about some changes that they have noticed in their cognitive abilities without consulting anyone. To our regret, few patients could be informed about the potential adverse effects of cancer therapy on the cognitive function in Japan. We think that it would be beneficial to provide the patients themselves or their families with information about the possible cognitive decline that can occur in elderly cancer patients receiving cancer treatment and about the possibility of rehabilitation to counter such decline, in terms of improving the quality of lives of the patients undergoing cancer treatment.

Efficacy of the intervention

In the current randomized controlled study, we successfully achieved improvement of the score on the FAB by intervention using speed-feedback therapy with a bicycle ergometer. We observed a significant difference in the change of the score on the FAB between the intervention and control groups using the two-way ANOVA. Although the amount of change of FAB scores was small, it is reported that only a small increase of FAB scores can lead to an improvement of IADL [19]. Moreover, we confirmed the independent efficacy of our intervention using stepwise multiple regression analysis, including various possible confounding factors, such as previous or ongoing treatment. However, we cannot completely rule out the possibility that other confounding factors may have influenced the results. On the other hand, we found younger age as another independent factor associated with greater improvement of the FAB score, maybe suggesting easier reversibility in these patients.

In regard to the mechanism underlying the improvement in cognitive function by speed-feedback therapy with a bicycle ergometer, Ootani et al [15] deduced that sustained attention and improved concentration, which are linked to the improvement of cognitive functions, are responsible for the improvement in the attention span of the subjects. Rowe [23] reported that the brain activity increases significantly during motor attention tasks, which may be one of the mechanisms explaining the improvement of the cognitive functions in elderly cancer patients following speed-feedback therapy with a bicycle ergometer, which includes an attention-sustaining element. Moreover, Winocur *et al.* [24] stated that it is possible to reverse the decline of cognitive functions in elderly cancer patients by undertaking rehabilitation focused on attention, which lends support to our contention in the present study that the attention-sustaining element of speed-feedback therapy with a bicycle ergometer was responsible for the improvement of the cognitive function in elderly cancer patients.

On the other hand, no improvement in the results of evaluation by the BI, IADL, or FACT-G was observed in the present study. The subject sample size may be one of the factors responsible for this. Because we computed the sample size in this study based on the changes in the FAB score, the sample size may have been insufficient to detect significant differences in the scores on the other evaluation scales. Another possible factor is the good functional state of the subjects. Because we used a performance status of 1 or higher as an eligibility criterion for this study, the mean

scores on the BI and IADL at baseline were 99.87 (SD 1.13) and 9.35 (SD 1.34), respectively, that is, almost perfect scores. Thus, the ceiling effect may have come into play preventing the appearance of any significant changes.

Expectations of holistic rehabilitation to maintain the patients' QOL to the greatest possible degree during protracted cancer therapy have increased [25]. In such background, assessment of the efficacy in this study of a rehabilitation intervention for cognitive decline in elderly cancer patients represents a new dimension in the rehabilitation of cancer patients. We also believe that the finding of this study that a physical exercise task involving a sustained-attention element can bring about an improvement of cognitive function will serve as a valuable material for future research on the rehabilitation of cancer patients. Moreover, our observation during the course of this study that there are significant numbers of elderly cancer patients who feel uneasy about their cognitive abilities and need to talk to someone about it is a matter that needs to be addressed with some urgency in clinical settings. It is hoped that other rehabilitation approaches for these patients, such as occupational therapy, are also adopted in the future. Further elucidation of the actual situation in regard to cognitive decline in cancer patients and how to deal with this problem will be necessary in order to provide appropriate support for such patients in the future.

Limitations and perspectives

Because the intervention group in this study was required to come to the hospital and talk with the therapist once a week, whereas the control group was not, it is difficult to rule out the possibility that the greater number of opportunities for the intervention group to go out and to talk to someone about their condition may have affected the results. However, because no significant differences in the subjects' occupations, exercise habits or functional status were observed between the two groups at baseline; it is hard to imagine that the intervention group just having the additional opportunity to go to the hospital and talk with the therapist once a week would have greatly affected the results. Nevertheless, it will be necessary to verify the efficacy of speed-feedback therapy with a bicycle ergometer after eliminating the potential influence of this factor on the results. Additionally, it should be examined whether speed-feedback therapy is more effective than other treatments that also sustain attention and improve concentration. Another limitation of this study is that we demonstrated the efficacy of this therapy by evaluations repeated twice. We should have repeated the follow-up evaluations after the intervention several times in order to examine the long-term effectiveness of this therapy. Furthermore, only breast and prostate cancer patients from a single institution were enrolled in this study, and we cannot deny the possibility of selection bias as a limitation of the study. Therefore, it is impossible at this time to generalize the results of our study. Also, although speed-feedback therapy with a bicycle ergometer has been shown to be effective in improving the frontal lobe function in elderly cancer patients, the underlying mechanism, duration of efficacy, and the effects on the daily life, including on the decision-making abilities of the subjects, have not yet been clarified Therefore, it will be necessary to expand the number of subjects and conduct a long-term study for further clarification of the efficacy of this therapy.

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Conflict of interest

The authors have declared no conflict of interest.

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