■ORIGINAL ARTICLE

Time Use for Occupation and the Expectations of People with Schizophrenia and Their Relatives from the Perspective of Themselves and Their Relatives

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Abstract: The objectives of this research were to compare time use for occupation: self care, work and leisure, from the perspective of people with schizophrenia and their relatives, and investigate the expectations of people with schizophrenia and of their relatives towards their time use, and the congruence of these. The time use checklists were used to interview seven people with schizophrenia and their relatives. The results demonstrated that there were significant differences among the time use of three types of occupation from both perspectives ($p < 0.05$). The most expectation of the participants was being able to earn a living.

Keywords: People with schizophrenia, Relatives of people with schizophrenia, Time use, Expectation

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Introduction

Schizophrenia is a chronic mental illness. Even if treatment is received, around two out of three schizophrenic patients have relapses. Additionally, the chronic conditions of most of these patients have affected their living functions [1] especially occupations in areas of daily living activities, work and leisure [2]. Routine occupations are important to maintain and promote mental health [3]. If occupational performance is lost or disturbed; well-being and satisfaction with life may decrease [4]. Therefore, the management of time use for occupations can be used to promote health and well-being. Alternatively, the study of time use for occupation is another method to understand the importance of each occupation: activities of daily living, work and leisure; which promote good health and well-being [3].

There are many studies focusing on time use for occupations of schizophrenic patients. For example, the study of Hays & Halford [5] showed that schizophrenic patients in a community participated less in occupations and spent most of their time on passive leisure and sleep. In 2003, the work of Shimitras, Fossey & Harvey [6] survey time use of people with schizophrenia and found that their time consuming occupations were sleeping, personal care and passive leisure. Moreover, the study of Minato & Zemke [7] demonstrated that schizophrenic patients in a community used their time for three occupations differently and used most of their time in self care including sleep as well. Apart from this, Bejerholm & Eklund [8] found that schizophrenic patients were lethargic in participating in occupations in terms of the patterns and time uses. Many people with schizophrenia have no structured occupation and perform occupations, which have little meaning to them [9]. People with schizophrenia often fail to accomplish occupational areas: work, self-care, and play, suitable to their ages [10].

Most studies in Thailand focused on time uses of schizophrenic patients who were admitted in hospitals; there is no study for those who live at home. Nevertheless, the survey of community need for rehabilitating psychiatric patients showed that the patients needed positive attitude from others, having jobs or careers, receiving medication consistently and conveniently,

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knowledge about their psychiatric diseases and how to look after themselves; the needs of their relatives, neighbours and leaders were the same as the patients apart from how to help and look after the patients appropriately. They also expected their relatives to take care of the patients on a more intimate level [11]. This study did not survey occupations that the psychiatric patients really performed in their communities or how they spent their time, which collected data from the patients themselves or their relatives.

Another study of the relationship between time use for occupation and volition of 60 schizophrenic patients aged 20−40 years, admitted at psychiatric hospital found that time use for work positively related to personal causation, however, time use for activity of daily living negatively related to personal causation, and time use for activity of daily living negatively related to value and interest [12]. This result implies that personal factors may affect the time use for occupation of schizophrenic patients when staying in hospitals. In addition, needs of people with schizophrenia to perform occupations, their living conditions [13], their accessibility to social contact [13, 14] and structured daily occupations [15] have been related to occupational performance of schizophrenic people.

From the previous review, the expectations of the patients themselves and their relatives may influence the types of occupation they perform or how they perform these occupations especially when living in the community. These factors may have impacts on how people with schizophrenia spend their time to perform occupations in their communities. Therefore, it is interesting to study time use for occupation and the expectations of those with schizophrenia who live in communities and their relatives from their own perspectives and their relatives. The sources of information from both people with schizophrenia and their relatives may be practical benefits for taking care of this vulnerable group in the community. The benefits of this study are useful for the patients and their relatives in order to manage time appropriately in daily life and also to meet their expectations.

The objectives of this research were to

1. compare time use from the perspectives of people with schizophrenia for occupation: self care, work and leisure,
2. compare time use from the perspectives of their relatives for occupation: self care, work and leisure,
3. investigate the expectations of people with schizophrenia and their relatives towards their time use, and the congruence of these.

Methods

Prior to the commencement of the study, human ethics approval was sought and given by Faculty of Associated Medical Sciences, Chiang Mai University

Participants

Seven people with schizophrenia and their relatives in Muang District, Chiang Mai participated in this study according to the following inclusion criteria:

1. people with schizophrenia who were diagnosed with schizophrenia by psychiatrists of Suanprung Psychiatric hospital
2. Discharged to live at their homes for at least 1 month
3. Homes were located in 1.5 kilometer from Faculty of Associated Medical Sciences which made it convenient to collect data, and were connected with telephones.
4. Were able to respond to the points, discuss their time use, and be willing to participate in this study.
5. Relatives of the above schizophrenic participants who were caregivers, able to provide information regarding time use of their schizophrenic relatives, and were willing to participate in this study.

Instruments

The instruments included as follows:

1. Record of demographic data and a record of daily time use, designed by the researchers
2. Time use survey checklist of Christiansen [16], which were translated and modified to Thai language and context by the researcher. This checklist was verified for Thai translation and modification to Thai context by an occupational therapy academic who graduated Doctor of Philosophy in occupational therapy from USA. This checklist includes 2 parts: part 1 consisted of demographic data and expectation; part 2 consisted of two sections as follows: Section 1 was a daily time use record for 7 days, which included what they had done and how much time they spend in each activity for each day; Section 2 was a record form of types of occupation and how much time they spent on each type of occupation for each day as well as time average of each type of occupation. The types of occupation comprised self-care, work and leisure as following details:
    1. Self-care referred to routine activities performing for personal cares such as eating, grooming, bathing and dressing, rest and sleeping
    2. Work referred to obligatory for pay, duties or volunteer activities such as paid work, volunteer

work, housework, caring the others, studying, training, or travel
3. Leisure referred to discretionary activities which did not disturb self-care and work such as exercise, recreation, shopping, social activities, watching television or movies or plays or exhibitions, reading, listening to music, surfing internet.

Process of collecting data

1. The researcher cooperated with the group of relatives of schizophrenic patients of Suanprung Hospital to recruit the participants.
2. Made appointments with 2 schizophrenic patients who lived at home to pre-test the ease of using a daily time use record, then revised this record for understanding and data collection.
3. Made appointments with the participants who were schizophrenic patients and their relatives to collect data.
4. Requested the participants to sign the consent forms and interviewed then regarding their demographic data and their expectations as shown in part 1 of the time use survey checklist, then asked them to fill a record of daily time use for 7 days in a section 1 of a part 2 after the explanations from the researchers. The researcher would telephone to remind them about recording the forms every day at 9 am for 7 days.
5. The researcher made appointments again to collect the record of daily time use after 7 days, then interviewed them to categorize types of occupations according to the definitions and components of each type of occupation as shown in a section 2 of a part 2 and calculated averages of time use for each type of occupation, and filled it in.
6. Checked the completion of the records and the checklists, and then analyzed the data.

Statistical analysis

SPSS (Statistical Package for Social Sciences V 17 for Windows) was used for the statistical analysis. In order to examine the comparison of time uses for occupation: self care, work and leisure from the perspectives of people with schizophrenia; and from the perspectives of their relatives, Friedman Two-way Analysis of Variance by Rank were conducted because the data distribution was not a normality. Afterwards, the multiple comparison tests using Wilcoxon Signed Ranks test were administrated to further examine the differences of pairs of time uses for each occupation.

Results

Demographic characteristics of people with schizophrenia and their relatives

Table 1 shows Demographic characteristics of people with schizophrenia and their relatives. Most people with schizophrenia were males, between 20−30 years, high school graduates, unemployed, and single. Most of their relatives were males of 60 years or more. Two relatives did paid work, three out of seven have had businesses, one was a housewife and the other one was a civil Servant. Five relatives received education levels below bachelors degree, and two of them were uneducated. Nevertheless, information regarding the marital status of their relatives was not applicable. In addition, most of their relatives (5) were parents and 2 others were a brother and a sister.

Time uses of people with schizophrenia and their relatives

Table 2 shows the amount of time used in 24 hours for self-care, work, and leisure. People with schizophrenia spent most of their time (69.17%) for self-care (median = 17.30, Q.D. = 14.0), then leisure (24.33%)

Table 1. Demographic characteristics of people with schizophrenia and their relatives

	Schizophrenics (n = 7)		Relatives (n = 7)	
	N	%	N	%
Gender				
Male	6	85.71	4	57.14
Female	1	14.29	3	42.86
Age (in year)				
20−30	3	42.85	–	–
31−40	2	28.57	1	14.28
41−50	1	14.29	1	14.28
51−60	1	14.29	1	14.28
≥ 60	–	–	4	57.16
Education				
Primary school	1	14.29	2	28.57
High school	3	42.85	1	14.29
Certification	2	28.57	2	28.57
Bachelor	1	14.29	–	–
Uneducated	–	–	2	28.57
Vocation				
Salaried	1	14.29	–	–
Paid work	–	–	2	28.57
Housewife	–		1	14.29
Unemployed	6	85.71	–	–
Civil Servant	–	–	1	14.29
Business	–	–	3	42.85
Marital status				
Single	6	85.71	N/A	N/A
Divorce	1	14.29	N/A	N/A

Note: N/A = Not applicable

Table 2. The comparison of the amount of time uses for self-care, work, and leisure of people with schizophrenia and of their relatives

Groups	Occupation	Mdn	Q.D.	%	Mean Rank	df	λ^2	p
Schizophrenics (n = 7)	Self-care	17.30	14.00	69.17	3.00			
	Work	0.42	0.25	6.50	1.14	2	12.29	.002*
	Leisure	4.42	4.09	24.33	1.86			
Relatives (n = 7)	Self-care	17.76	12.68	67.24	3.00			
	Work	1.98	0.43	11.14	1.14	2	12.29	.002*
	Leisure	4.80	4.26	21.62	1.86			

Mdn = Median, Q.D. = Quartile, *$P < 0.05$

Table 3. The comparison of the amount of time uses for self-care, work, and leisure of people with schizophrenia and of their relatives in pairs

Groups	Occupation	Rank−		Rank+		Z	p
		N	Mean	N	Mean		
Schizophrenics (n = 7)	Work-Self-care	7	4.00	0	0.00	−2.37	.018*
	Leisure-Self-care	7	4.00	0	0.00	−2.37	.018*
	Leisure- Work	1	1.00	6	4.50	−2.20	.028*
Relatives (n = 7)	Work-Self-care	7	4.00	0	0.00	−2.37	.018*
	Leisure-Self-care	7	4.00	0	0.00	−2.37	.018*
	Leisure- Work	1	4.00	6	4.00	−1.69	.091

*$P < 0.05$

(median = 4.09, Q.D. = 4.42) and the least amount of time for work (6.50%) (median = 0.42, Q.D. = 0.25). Relatives viewed that schizophrenics spent most of their time (67.24%) for self-care (median = 17.76, Q.D. = 12.68), secondarily for leisure (21.62%) (median = 4.80, Q.D. = 4.26) and the least time for work (11.14%) (median = 1.98, Q.D. = 0.43). Moreover, this table shows the comparison of time uses for self-care, work, and leisure of people with schizophrenia using a Friedman test, which demonstrates significant difference ($\lambda^2 = 12.29$, $P < 0.05$). Additionally, there was a significant difference of time uses for self-care, work, and leisure of people with schizophrenia from the perspectives of their relatives, using a Friedman test ($\lambda^2 = 12.29$, $P < 0.05$). After this test, Table 3 shows the comparison of self-care, work, and leisure of people with schizophrenia in pairs using Wilcoxon Signed Ranks test, which demonstrates significant difference of the amount of time uses between work and self-care ($Z = -2.37$, $P < 0.05$), leisure and self-care ($Z = -2.37$, $P < 0.05$), and leisure and work ($Z = -2.2$, $P < 0.05$). In addition, this table shows the comparison of the amount of time uses for self-care, work, and leisure of people with schizophrenia from their relatives' perspectives in pairs, using Wilcoxon Signed Ranks test, which demonstrates significant difference in the amount of time uses between work and self-care ($Z = -2.37$, $P < 0.05$), and leisure and self-care ($Z = -2.37$, $P = 0.05$), but not between leisure and work ($Z = -1.69$, $P > 0.05$).

Table 4. The expectation for use of time

	Schizophrenics (n = 7)		Relatives (n = 7)	
	Numbers	%	Numbers	%
Earning a living	4	57.14	3	42.85
Doing a little housework	3	42.86	2	28.57
Looking after himself in his medication routine and seeing the doctors according to an appointment			1	14.29
Going out to interact with friends			1	14.29

The expectation for use of time

Table 4 shows the numbers and percents of expectations of people with schizophrenia toward their time uses and their relatives. The expectations of people with schizophrenia and their relatives were that the subjects would be earning a living and doing a little housework respectively. One relative expected the patient in looking after himself in his medication routine and seeing his doctors according to his appointments. Another relative expected a schizophrenia person to go out to interact with friends.

Discussion

The schizophrenic patients spent time for self-care, leisure and work respectively; there were significant differences of time use for self-care, work and leisure from both sources of information as shown in Table 2. Nevertheless, from the perspectives of their relatives, the differences of time use of the patients with schizophrenia for leisure and work was not significantly different as demonstrated in Table 3. The patients spent most time in self-care, which included sleep. This result is compatible with the survey of time use for adults in the United State which found that they spent 30% of 24-hour day on sleeping and 10% on self-care activities including eating because this occupation is obligatory activity influenced by biological rhythms [3]. Most participants in this study were male adults of working age but most of them were unemployed so that they spent more time on self-care and leisure than for work. This result is compatible with the study of Weeder [17] which showed people with schizophrenia spent more time on sleep and passive leisure and less time in work. In addition, it is also congruent with the study of Minato and Zemke [7], which found that non-working schizophrenic patients spent more time on sleep and rest, and play.

The differences of time uses for self-care, work and leisure may have resulted from psychiatric symptoms, lethargy, lack of motivation and regression, which affect occupational performances of the schizophrenic participants [2]. The perspectives of people with schizophrenia and their relatives is congruent except time use for work as presented in Table 2. Their relatives provided information that the schizophrenic members spent more time for work than the patients themselves did (see Table 2) and spent time for work and leisure with the difference that was not significant (see Table 3). Most schizophrenic participants were between 20−40 years, which are adult ages, and their relatives felt that they were supposed to use more time for work such as earning a living and doing a little housework as presented in Table 3. This is compatible with the statement of Christiansen [3] that work is classified as obligatory activity for adults and 25% of their daily time is spent on work. Moreover, schizophrenia may affect attention, executive function, verbal & visual memory, and working memory of the patients [18, 19], which have an impact on their work. In addition, work performance limitation may result from the deficit of concept formation ability of the schizophrenic patients which is a part of executive function [20]. In Thai context, if the patients can do or help in housework, their relatives will perceive that they can work [21], however, most patients (85.71%) were male and he should take a role of earning a living for his family [22]. For these reasons, it is possible that their work performance may not be as effective as their own perception so that they viewed that their time use for work was less than the perspectives of their relatives on time use of schizophrenic patients for work.

The expectations of the schizophrenics and relative participants were congruent in items of earning a living and doing a little housework because 85.71% of schizophrenic participants were unemployed and most of them were working ages. Due to the chronic condition of schizophrenia [23], which usually has the recurrence of symptoms when the patients encounter some pressure conditions [25], their function may be lost, especially work. Nevertheless, most relatives expected them to work to support themselves. Most relatives were aged 60 years or more, and it is possible that these patients were a burden to the senior relatives; hence they expected the schizophrenic members to earn a living to pay off loans of the families. In addition, 42.85 percent of their relatives conducted business or self-employments, they may need helping for these from the schizophrenic patients because gaining income for the family improves their relatives' quality of life [26] and being employed by other organizations is difficult for the patients [21].

Furthermore, one relative expected the schizophrenic members to look after themselves in medication and seeing the doctors because they need continuous treatment [23]. In addition, due to schizoid personality [25], another relative would like the schizophrenic members to interact with others. Since social and community functioning deficits of schizophrenic patients are stressful for them, they contribute to relapse [27, 28], and on the other hand, social skills develop social network for the patients and support their effective coping with daily stresses [27, 29]. Social interaction in the community should be useful for schizophrenic people to prevent their stress and recurrence. In addition, Tsang [30] and Tsang & Pearson [31] reported from their research that social skills training was effective at helping people with schizophrenia to engage in work. For these reasons, the relative would like them to develop social skills via going out to interact with friends.

Conclusion and Recommendation

People with schizophrenia used their time for self-care, leisure and work respectively. Most expectations of them were earning living and doing a little housework, and so did their relatives. This study recommended the cooperation between people with schizophrenia and their relatives in time management in order to prevent recurrence.

Acknowledges

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Conflicts of interest

None

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■ORIGINAL ARTICLE

Risk Factors for Impaired Instrumental Activities of Daily Living in Alzheimer's Disease

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Abstract: Objective: Despite the considerable importance of maintaining support for instrumental activities of daily living (IADLs) for patients with dementia living at home, there have been no formal investigations of what factors influence IADLs.

Method: We administered various neuropsychological tests, the Timed Up and Go [TUG] test, and the Geriatric Depression Screening Scale-15 to 54 individuals in Japan who had visited a day care center or a preventative care class and who had either 23 mild Alzheimer's disease (mild AD) or 31 no dementia. IADLs were measured using the Self-Report Frenchay Activities Index.

Results: The factors related to the domestic chores subscale of the Frenchay Activities Index were gender, backward digit recall performance (Wechsler Memory Scale-Revised [WMS-R]), and TUG test performance (R^2 = 0.53). Factors related to the leisure/work subscale were backward digit recall and logical memory II performance on the WMS-R, scores on the Behavioral Assessment of the Dysexecutive Syndrome, and TUG test performance (R^2 = 0.66). Finally, factors related to the outdoor subscale were backward digit recall, logical memory II, and the TUG test performance (R^2 = 0.62).

Conclusions: The factors affecting IADLs among elderly individuals with mild AD or no dementia vary depending on the type of IADL. Notably, TUG test performance has a direct influence on all IADL types, and might relate to cognitive function. When providing preventative care or IADL support, it may be beneficial to evaluate and intervene with a focus on the cognitive and physical functions highlighted in this study.

Keywords: Alzheimer's disease, cognitive function, environmental factors, neuropsychological tests

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Introduction

There were an estimated 5.2 million people with Alzheimer's disease (AD) in the United States in 2013 [1]; therefore, policies to combat AD constitute an urgent international priority. The Japanese population has aged at an accelerated rate in recent years. In addition, in 2012, the Ministry of Health, Labour and Welfare reported that the population of individuals with dementia had reached 3 million [2]. AD and cerebrovascular disorders with comorbid AD account for approximately 70−80% of dementia cases [2].

In response to the rapid increase in dementia cases, the Ministry of Health, Labour and Welfare established the 5-year "Orange Plan" to promote policy measures against dementia. One of the concrete features of the plan is the improvement of at-home, early-term, intensive support for cognitive function for individuals with early-stage dementia. More specifically, it aims to create additional opportunities for provision of support for activities of daily living (ADLs) for people with very mild or mild AD. Although it is possible for these individuals to perform certain home-based ADLs, such as feeding themselves and using the toilet, they are known to experience difficulty performing "instrumental" ADLs (IADLs), such as shopping and household budgeting/money management [3]. Indeed, according to Ueda, Takayama, Koyama, and Osaka's independent IADL survey [4], Laurent et al.'s 8-item IADL scale [5], and

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the Alzheimer's Disease Cooperative Study IADL scale developed by Galasko et al. [6], individuals with mild AD showed impaired IADL performance. All of these reports mentioned similar impairment in performance of IADLs, including meal preparation (e.g., cooking), traveling to a particular location for the first time, keeping one's home and oneself neat and tidy, and managing finances, in patients with mild AD. Previous research showed that individuals with mild AD experienced disability in specific types of IADL; therefore, it is logical to assume that different types of IADL are affected by different factors.

According to the diagnostic criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision [7] and a report created by the National Institute of Neurological and Communicative Disorders and Stroke, in collaboration with the Alzheimer's Disease and Related Disorders Association [8], cognitive disorders associated with memory loss have been implicated in IADL impairment in mild AD. Indeed, amnesia-like memory impairment is a confirmed characteristic of individuals with AD and one of the core clinical criteria for diagnosis of the disorder [9]; furthermore, memory impairment is listed as a prominent symptom that begins during the early stages of probable dementia of the Alzheimer's type, while anterograde amnesia is particularly apparent in early-phase AD [10]. According to Perry and Hodges [11], impairment of attention and visuospatial cognition, in addition to memory impairment, occur in AD. Kramer et al. [12] reported that the amnesic type of mild cognitive impairment, which has a high rate of progression to dementia, was accompanied by impaired attention and executive function disorders. We performed a desk study, which involved scoring IADLs and examining factors affecting them, and found that constructional ability, working memory, executive function, and memory all influenced IADLs [13]. In accordance with these findings, we hypothesized that the cognitive impairment (including impairment of visuospatial cognition, attention, working memory, executive function, and memory) described in previous studies would exert a direct influence on IADLs in AD.

In addition, depression is common in people with AD and has been found to affect IADL. In Japan in particular, mild AD is frequently accompanied by depression [14], which leads to motivational (volitional) decline; therefore, it is reasonable to speculate that it affects IADL performance.

There are several methods, including the Alzheimer's Disease Cooperative Study IADL scale [6], Frenchay Activities Index (FAI) [15, 16], and Tokyo Metropolitan Institute of Gerontology Index of Competence [17], available for use in evaluating IADLs in elderly individuals and people with AD. Moreover, the FAI has been used to evaluate IADLs in elderly individuals and people with various diseases [18−21]. These IADL scales include all "housework" and "outdoor activities." Therefore, both cognitive function and bodily function are likely to influence IADL in people with AD.

There are currently three main types of support available for Japanese people with mild AD: (a) drug therapy; (b) treatment of secondary symptoms to maintain psychological security; and (c) use of social services including those provided via long-term care insurance. However, few studies have been conducted to examine the adequacy of these types of ADL support for people with mild AD, who usually live at home, or the factors responsible for specific IADL difficulties. Because there are few reports that describe the relationship between functional impairment and IADL disability of AD patients. This information would be invaluable for those who provide IADL support and could help in the selection of useful assessment methods. Therefore, we sought to identify factors related to cognitive, psychological, and physical functioning affecting IADLs in elderly people with mild AD and individuals without dementia (i.e., non-dementia [ND] group).

Method

Subjects

The study included 54 subjects: 23 with mild AD and 31 no dementia (Table 1). The mild AD group included patients who were diagnosed with AD by psychiatrists or neurologists during an outpatient examination and undergoing ambulatory rehabilitation at one of three health centers for the elderly. Rehabilitation staff determined whether the mild AD group had very mild or mild dementia, using the Clinical Dementia Rating scale (i.e., scores of 0.5 or 1 respectively). Subjects with a history of other central nervous system diseases were excluded from the study. The 23 subjects in the mild AD group were all local community residents.

The ND group included 31 elderly people enrolled in aged-care prevention classes (i.e., classes that teach

Table 1. Characteristics of the subjects

	ND group	mild-AD group	*t*-test
People (man:woman)	31 (7:24)	23 (3:20)	*p*-value
Age (year)	76.7 ± 6.0	79.9 ± 7.1	n.s.
MMSE	28.32 ± 1.68	20.65 ± 3.58	< 0.001
CDR	0	0.5 or 1	−

ND; Non-Dementia Elderly persons AD; Alzheimer's disease
CDR; Clinical Dementia Rating

older adults to prevent the onset of problems necessitating home-based care). We excluded individuals with Mini-Mental State Examination scores of < 24 or a history of other central nervous system diseases. ND group members who met the selection criteria were volunteers at one of two health centers for the elderly or participants in aged-care prevention classes at one of three sites. All subjects in both groups were able to walk independently or with the assistance of a T-cane.

All subjects received written descriptions of the study and provided written informed consent. People with AD had previously listened to oral descriptions of the study, provided by a family member or caregiver. The study was approved by the research ethics committee at the university with which the first author was affiliated (Approval No. 2010C0018).

IADL Evaluation Methods

IADLs were evaluated using the Japanese version of the FAI, or Self-Rating FAI (SR-FAI) [22]. We used the SR-FAI because it provides a number of IADL categories and is therefore a sensitive measure of IADLs and better suited to examination of specific influential factors. Holbrook and Skilbeck [16] described a three-factor structure for the original FAI: domestic chores, leisure/work, and outdoor activities (Table 2).

The SR-FAI includes 15 items pertaining to IADLs, such as walking and employment activities, divided between three subscales. Although the items are scored using a scale ranging from 1 to 4 in the original FAI, the scale in the SR-FAI ranges from 0 to 3; therefore, total scores differ between the two versions [16, 22]. It should be noted that the factor structure for the Japanese version has not been validated. In addition, the SR-FAI was amended, resulting in differences in scale ranges (either from 1 to 4 or from 0 to 3) according to item [22]. The original SR-FAI (prior to amendment) was used to identify predictors in the original FAI's three-factor structure, as it was closer to the original scoring method; in addition, we recalculated scores to reflect a scale range of 1 to 4 rather than 0 to 3. The score stage is not different from an original FAI in between an SR-FAI.

Table 2. Comparison of the Original Frenchay Activities Index (FAI) and The Self-Rating Frenchay Activities Index

	Original FAI		SR-FAI	
	Activities	Score	Activities	Score
Factor 1: Domestic chores	Preparing main meals (Preparing meals)	1−4 a*	Preparing meals	0−3
	Washing-up (Washing dishes)	1−4 a*	Washing dishes	0−3
	Washing clothes	1−4 b*	Washing clothes	0−3
	Light housework (Dusting/Vacuum cleaning)	1−4 b*	Dusting/ Vacuum cleaning/Clear up	0−3
	Heavy housework (Cleaning)	1−4 b*	Heavy housework (hanging up *futon* bedding for airing and taking it down, cleaning floors)	0−3
	Domestic chores total points	5−20		
Factor 2: Leisure/work	Social outings	1−4 b*	Social outings	0−3
	Pursuing active interest in hobby (Hobby/sport)	1−4 b*	Pursuing active interest in hobby (Hobby/sport)	0−3
	Outings/car rides	1−4 c*	The use of public transport (bicycle, car, bus, airplane)	0−3
	Household and /or car maintenance	1−4 d*	Household and/or car maintenance	0−3
	Gainful work (Employment)	1−4 f*	Gainful work (Employment)	0−3
	Leisure/work total points	5−20		
Factor 3: Outdoors	Walking outdoors > 15 min.	1−4 b*	Walking outdoors > 15 min.	0−3
	Driving a car/travel on bus	1−4 b*	Driving a car/travel on bus, airplane etc.	0−3
	Gardening	1−4 d*	Gardening	0−3
	Reading books	1−4 e*	Reading books	0−3
	Local shopping	1−4 b*	Shopping	0−3
	Outdoor total points	5−20		
Total points		15−60		0−45

FAI code
a* 1 = Never, 2 = Under once weekly, 3 = 1−2 time a week, 4 = Most days
b* 1 = Never, 2 = 1−2 times in 3 months, 3 = 3−12 times in 3 months, 4 = At least weekly
c* 1 = Never, 2 = 1−2 times in 6 months, 3 = 3−12 times in 6 months, 4 = At least weekly
d* 1 = None, 2 = Light, 3 = Moderate, 4 = All necessary
e* 1 = None, 2 = 1 in 6 months, 3 = Less than 1 a fortnight, 4 = Over 1 a fortnight
f* 1 = None. 2 = Up to 10 h/week, 3 = 10−30 h/week, 4 = Over 30 h/week
The codes of Original FAI and SR-FAI are the same

Therefore, as 0−3 points were awarded, the method used to recalculate scores added a point. The SR-FAI was administered to subjects in the ND group via face-to-face interviews with the first author, and AD group of family members were asked to complete SR-FAI forms.

Neuropsychological, Depression, and Physical Function Tests

We used the following tests to identify predictors of IADLs. The neuropsychological evaluation included measurement of attentional functioning, memory, visuospatial cognitive function/constructional function, and executive function. Attentional functioning was measured using the backward digit span and mental control tasks, which were Wechsler Memory Scale-Revised (WMS-R) subtests. Memory was assessed using logical memory II, which is also a WMS-R subtest. Visuospatial cognitive/constructional function was measured using the clock-drawing test. Executive function was measured using the Behavioural Assessment of the Dysexecutive Syndrome (BADS).

The WMS-R logical memory II subtest was selected because it is a delayed-recall memory test and therefore appropriate for detecting anterograde amnesia, a major AD symptom. The scoring criteria established by Rouleau, Salmon, Butters, Kennedy, and McGuire [23], which involve an 11-step evaluation with scores ranging from 0 to 10, were used to score the clock-drawing test. Concerning the BADS, a floor effect was confirmed for the Zoo Map Test. Specifically, the entire mild AD group exhibited low scores; therefore, the test was excluded. Total scores for the remaining tests (rule shift cards, action program, key search, temporal judgment, and modified six element tests) were included in the analysis, with a highest possible score of 20 for each test.

The Geriatric Depression Scale-15 (GDS-15) was used to screen for depression. This is a simple test, for which responses of "yes" or "no" are provided. Total scores range from 0 to 15, with scores of 0−5 and ≥ 6 indicative of no depression and depression, respectively.

As some SR-FAI items assess outside walking ability or repeated changes in direction and movement within a narrow area while cleaning, we used the Timed Up and Go (TUG) test to measure physical function, because it is a balance test and evaluates walking and changes in direction. Specifically, the TUG test measures the time required to rise from a seated position, walk for 3 m, return to the seat, and sit down. A stopwatch was used to record TUG test times, in seconds.

Data Analysis

We performed between-group comparisons using t tests or the Mann-Whitney U test ($p < 0.05$) to determine differences in WMS-R, the clock-drawing test, BADS, GDS-15, TUG test, and SR-FAI scores between the mild AD and ND groups. We also used the Shapiro-Wilk test as the normal distribution test. In addition, we examined factors influencing SR-FAI scores (WMS-R, clock drawing test, BADS, GDS-15, TUG test), using multiple regression analysis with the three SR-FAI subscale scores as dependent variables after cancellation the two groups. Age, sex (male = 1, female = 2), neuropsychological test and GDS-15 scores, and TUG test performance (in seconds) were included as independent variables.

We then performed multiple regression analysis using the stepwise method, with independent variables ($p < 0.05$).

All statistical analyses were performed using IBM SPSS Statistics Ver. 21 (IBM Corp., Armonk, NY).

Results

Result of the normality test

As a result of the Shapiro-Wilk test, no normal distribution was found in the results of WMS-R mind-control tasks, WMS-R digit span backward, WMS-R logical memory II, the clock drawing test, and GDS-15. However, for BADS, the TUG test, and SR-FAI, normality was recognized.

Between-Groups Comparison

Table 3 shows the results of the between-groups comparison of SR-FAI scores and other variables. GDS-15 scores did not differ significantly between groups. However, SR-FAI, neuropsychological test, and TUG test scores in the mild AD group were significantly lower relative to those of the ND group ($p < 0.05$).

Multiple Regression Analysis

To ensure that we avoided multicollinearity between independent variables, we calculated the variance inflation factor, which was < 3.0; therefore, multicollinearity was assumed to be under control (Table 4). Risk factors for the domestic chores subscale included backward digit span ($\beta = 0.42$, $p < 0.001$) and TUG test ($\beta = -0.42$, $p < 0.001$) performance and sex ($\beta = -0.26$, $p < 0.001$). The weight determination coefficient by these factors was $R^2 = 0.56$; root mean square error was 4.40. Risk factors for the leisure/work subscale included backward digit span ($\beta = 0.22$, $p = 0.029$), logical memory II ($\beta = 0.29$, $p = 0.01$), and TUG test ($\beta = -0.23$, $p = 0.017$) performance and total BADS score ($\beta = 0.31$, $p = 0.008$). The weight determination coefficient by these factors was $R^2 = 0.66$; root mean square error was 2.69. Risk factors for the outdoor activities subscale includ-

Table 3. Results of each evaluation and SR-FAI

		ND group n = 31 Mean ± SD	mild-AD group n = 23 Mean ± SD	*p*-value
Executive function test	BADS	13.5 ± 2.6	7.2 ± 2.5	*** *a*
Balance test	Timed Up and Go test	11.2 ± 12.7	17.2 ± 5.6	* *a*
SR-FAI	Domestic chores	13.1 ± 4.7	7.5 ± 4.6	*** *a*
	Ieisure/work	14.5 ± 2.9	7.4 ± 2.3	*** *a*
	Outdoors	15.3 ± 3.4	8.2 ± 3.7	*** *a*
Attentional function test	WMS-R mind-control tasks	5.13 ± 0.16	3.3 ± 2.3	*** *b*
	WMS-R digit span backward	6.5 ± 1.9	4.2 ± 1.5	*** *b*
Memory test	WMS-R Logical Memory II	13.4 ± 9.0	0.3 ± 0.8	*** *b*
Visuospatial cognitive function/ Constructional function test	Clock Drawing Test	9.4 ± 1.5	6.7 ± 2.4	** *b*
Depression screening	GDS-15	3.0 ± 2.6	3.0 ± 2.3	n.s *b*

***$p < 0.001$ **$p < 0.01$ *$p < 0.05$

a = *t*-test, *b* = *Mann-Whitney U* test
ND; Non-Dementia Elderly persons AD; Alzheimer's disease WMS-R; Wechsler Memory Scale-Revised
BADS; The Behavioural Assessment of the Dysexecutive Syndrome
GDS-15; Geriatric Depression Screening Scale-item 15 SR-FAI; The Self-Rating Frenchay Activities Index

Table 4. Impact factor of FAI; Result of multiple regression analysis

Dependent variable	Independent variable	Standard β	*t*	*p*-value	VIF
Domestic chores	Gender	0.25	2.68	0.001	1.01
	WMS-R digit span backward	0.42	3.91	< 0.001	1.10
	Timed Up and Go test	−0.42	−4.02	< 0.001	1.11
Ieisure/work	WMS-R digit span backward	0.22	2.24	0.029	1.42
	WMS-R Logical Memory II	0.29	2.47	0.017	2.03
	BADS	0.31	2.78	0.008	1.78
	Timed Up and Go test	−0.23	−2.48	0.017	1.22
Outdoors	WMS-R digit span backward	0.35	3.42	0.001	1.40
	WMS-R Logical Memory II	0.28	2.70	0.009	1.50
	Timed Up and Go test	−0.38	−3.99	< 0.001	1.19

VIF; Variance Inflation Factor WMS-R; Wechsler Memory Scale-Revised
BADS; The Behavioural Assessment of the Dysexecutive Syndrome

ed backward digit span (β = 0.35, $p = 0.001$), logical memory II (β = 0.28, $p = 0.009$), and TUG test (β = 0.38, $p < 0.001$) performance. Further, the weight determination coefficient by these factors was $R^2 = 0.62$; root mean square error was 3.15.

Discussion

The study identified factors (i.e., sex and cognitive, neuropsychological, and physical functioning) that predicted IADL performance (as measured via the three SR-FAI subscales) in people with mild AD or no dementia. Notably, the contributions made by the variables to the variance in the three SR-FAI subscale scores were as follows: domestic chores: $R^2 = 0.53$, leisure/work: $R^2 = 0.66$, and outdoor activities: $R^2 = 0.62$. Therefore, they explained a substantial proportion of the variance.

Factors predicting domestic chore scores included backward digit span and TUG test performance and sex. The domestic chores subscale represents habitual household tasks performed regularly by subjects for many years. Therefore, working memory (i.e., backward digit span performance) and balance (i.e., TUG test performance) naturally contributed to performance of these tasks. The inclusion of meal preparation and cleaning as domestic chores could explain why sex was identified as a risk factor, as women perform approximately 80% of these domestic chores in Japan [24]. Here, we noticed that cultural differences existed in the original FAI and SR-FAI's heavy housework, which includes "hanging up futon bedding for airing and taking it down, cleaning floors" (Table 2). In Japan, such housework is often done by old women. Therefore, there is a possibility that the heavy housework chores in Japan have further

extracted gender as a risk factor.

The leisure/work subscale showed slightly different risk factors, including BADS scores and logical memory II, backward digit span, and TUG test performance. Leisure/work IADLs involve social outings, hobby-related activities, and gainful employment. Relative to domestic chores, leisure/work IADLs are less habitual and require planning and predictive skills (i.e., the ability to foresee results). Therefore, delayed recall memory (i.e., logical memory II performance) and executive function (i.e., BADS score) are likely to be required for these activities.

Furthermore, outdoor activities subscale scores were predicted by logical memory II, backward digit span, and TUG test performance; these results suggest that attention, working memory, and delayed recall memory all exerted a strong influence on outdoor activities. Notably, BADS scores did not predict outdoor activities, which include driving, riding on a bus, and shopping, even though executive function is likely to be required for such tasks.

This result shows that leisure/work requires more performing executive function than outdoor activities. Also, logical memory II (delayed recall memory) and backward sounding (attention and working memory) are the basic elements of the execution function. From these facts, in the case of the outdoor activities, there is a possibility that attention, working memory, and recall memory, which is the foundation element of outdoor activities, has a stronger influence than the execution function.

Piquard et al. reported that there was no correlation between IADL scores of AD patients and BADS score [25]. Monaci et al. reported that AD patients initially recognized an association between the executive functions scale and the IADL scale but that there was no association after 18−24 months [26].

From these facts, when investigating factors affecting IADL of AD patients, it may be better to use the fundamental elements of executive functions (such as attention and working memory) rather than BADS. Furthermore, the influence of the relationship between IADL and executive functions may be lowered depending on the degree of progression of AD symptoms. The current result also showed that the outdoor activities in IADL may indicate that it is an activity that causes the executive functions function to disappear from early on.

TUG test performance was identified as a common risk factor for all three SR-FAI subscales. It is likely that TUG test performance influenced domestic chores because they involve mainly indoor household tasks, such as meal preparation and doing laundry, and performance of these chores within the narrow spaces in Japanese homes necessitates numerous changes in direction and posture (from squatting to standing), requiring good balance. Leisure/work and outdoor activities both include movements over a broad area; therefore, good walking ability and directional changes (both assessed via the TUG test) would be required for these activities.

Another possible reason for identification of TUG test performance as a risk factor for all three types of IADL is that cognitive functioning could influence physical functioning, as suggested by the finding that the mild AD group's TUG test performance was significantly worse relative to that of the ND group (Table 3). In a study involving people with mild cognitive impairment, McGough et al. [27] found that TUG test performance was associated with cognitive function, and Voelcker-Renhage, Godde, and Staudinger [28] reported strong relationships between fitness in exercises requiring speed, balance, and fine motor coordination, and executive function and perception speed, which are related to activity in the frontoparietal network. Moreover, lower levels of activity in the temporal lobe's inner surface, posterior cingulate gyrus, and parietal cortex have been reported in individuals with mild AD [29,30], but motor activity impairment has not been observed during the early stages.

However, it is possible that deterioration of parietal function in mild AD influenced TUG test performance via mediation of the frontoparietal network. In other words, cognitive decline could have affected IADL indirectly via physical function (i.e., TUG test performance).

Age was not significantly associated with any of the FAI factors. Although aging is associated with both physical and cognitive decline, the results indicated that it did not exert an independent effect on IADLs beyond an indirect influence exerted via cognitive and physical function.

Because motivational (volitional) decline could also affect IADLs, the GDS-15 was used to screen for depression; however, the results showed that depression did not affect IADLs. This could have been because people with severe depression were not included in the sample (Table 3).

Overall, the results indicate that the factors influencing IADLs in the ND and mild AD groups differed according to IADL category. The results regarding neuropsychological tests (i.e., working memory, delayed recall memory, and executive function) are consistent with those of Albert, Moss, Tanzi, and Jones [31], who reported that verbal and auditory memory tasks, the Part B of the Trail Making Test for executive function, and the backward digit span test were all indices of progression from health to mild AD. The study was novel in that it demonstrated the ways in which the effects of

cognitive function on IADLs differed according to IADL category, suggesting that certain cognitive functions could be prioritized during IADL-related rehabilitation. Furthermore, the finding that TUG test performance influenced all three SR-FAI subscales indicates that walking balance was important in IADLs (or that cognitive function influenced walking balance) in both groups. Therefore, it is worthwhile to evaluate both cognitive function and walking/balance in elderly individuals participating in dementia-prevention activities or receiving home-based care for AD. The neuropsychological tests and TUG should be used to evaluate daily support services, and the results could assist doctors and therapists in determining necessary services for patients.

Study Limitations and Future Recommendations

One of the limitations of this study was that the subjects were ambulatory rehabilitation patients or participated in aged-care prevention classes, at three health centers for the elderly. Therefore, the results might not be generalizable to ambulatory patients at other institutions or elderly residents in other areas.

Rapcsak, Croswell, and Rubens [32] and Okazaki, Kasai, Meguro, Yamaguchi, and Ishii [33] reported that IADL performance in individuals with AD was affected by executive function and apraxia. Moreover, Grossi, Becker, Smith, and Trojano [34] found that attention-allocation disorders arose in individuals with AD because of a reduction in their ability to perceive stimuli simultaneously. Therefore, another limitation of the study was that apraxia and attention-allocation disorders were not considered, even though there appears to be sufficient evidence to warrant examination of cognitive disorders affecting IADL performance. In addition, we did not consider apathy, which could lead to reductions in motivation and interest in performing IADLs. Furthermore, the study was biased in terms of sex, as the sample included 44 women and only 10 men, which could have affected the results. Future research is required to clarify the effects of apraxia, attention-allocation functions, depression, apathy, and sex differences in IADL.

Conclusion

Overall, the results indicated that the effects of the cognitive and physical function variables differed according to IADL type. The finding that TUG test performance was related to all IADL types could have occurred because it is sensitive to cognitive impairment or exerted a strong direct effect on IADLs in a general sense. Evaluations and interventions that involve the cognitive and physical functions identified in this study could be beneficial in activity planning for the provision of IADL support to individuals with mild AD or no dementia in aged-care prevention classes and ambulatory rehabilitation.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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■RAPID COMMUNICATIONS

Relationship of Unaffected Grip Strength and Trunk Function with Toileting Performance in Stroke Patients

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Abstract: Purpose: Toileting independence is important for patients to maintain self-esteem and to return home. Unaffected grip strength and trunk functions have been noted in earlier studies to be associated with toileting independence in stroke patients. The objective of this study was to explore appropriate indices and calculate cut-off values with regard to unaffected grip strength and trunk functions that could be completed in a short time for estimating toileting independence in stroke patients.
Methods: The subjects were 37 stroke patients, each of whom scored at least 21 points in the Revised Hasegawa's Dementia Scale. The patients were divided into independent and non-independent toileting groups by FIM® scores related to toiling items ("Toileting" and "Toilet transfer"). Logistic regression and receiver operating characteristic curve were used to elucidate items that showed an association with the presence or absence of toileting independence, and to calculate cut-off values of grip strength and trunk function from the Stroke Impairment Assessment Set as variables.
Results: Grip strength was significantly associated with toileting independence. The cut-off value was 3 points (sensitivity, 74%; specificity, 71%; receiver operating characteristic area under the curve, 0.730).
Discussion: Because grip strength can be quickly measured, calculated grip strength cut-off values can estimate a patient's ability for toileting independence. However, the cut-off value shown in the present study may be applicable to only patients with good trunk function.

Keywords: toileting independence, grip strength, stroke

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Introduction

Toileting independence requires independence in activities such as manipulating lower garments and transferring to a toilet. However, these activities are some of the most challenging tasks for stroke patients [1]. Toileting independence is important for patients to maintain self-esteem and requires proper evaluation in rehabilitation settings because it is associated with patients' likelihood of returning home [2].

In an earlier study on toileting independence in stroke patients, Sato et al. [3] reported that balance function is important for toileting independence, and is integral for acts like transferring to the toilet seat. A balance function score of approximately 42 in the Berg Balance Scale (BBS), a typical balance index, is required. The BBS cut-off value that Sato et al. calculated in the same report can serve as a target value during balance exercises directed toward toileting independence, and as an index for estimating toileting independence. If occupational therapists, physical therapists, nurses, and other medical professionals have information on BBS scores in addition to functional state of cognitive and physical activity in the early stages of post-stroke recovery, they would be better able to understand patients' toileting assistance and other support needs beforehand, and would be able to make various preparations such as environmental adjustments. However, it takes approximately 20 min to complete the BBS, which means that the BBS

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is not easy to use as an index for determining toileting independence. Therefore, an assessment that could be completed in a short time was needed.

Other factors associated with toileting independence include grip strength [4], and trunk function [5−7]. We believe that these factors can provide useful cut-off values that are capable of distinguishing patients with toileting independence from those with non-independence in a similar manner to the aforementioned BBS. The objective of this study was to explore indices that might easily and quickly estimate toileting independence in stroke patients. We hypothesized that we could achieve this by calculating cut-off values and verifying their accuracy, using unaffected grip strength and trunk functions as indices, both of which are associated with toileting independence [5−7]. Rehabilitation therapists can use this in combination of information of functional status from other assessments and observations to make more informed decisions about toileting independence.

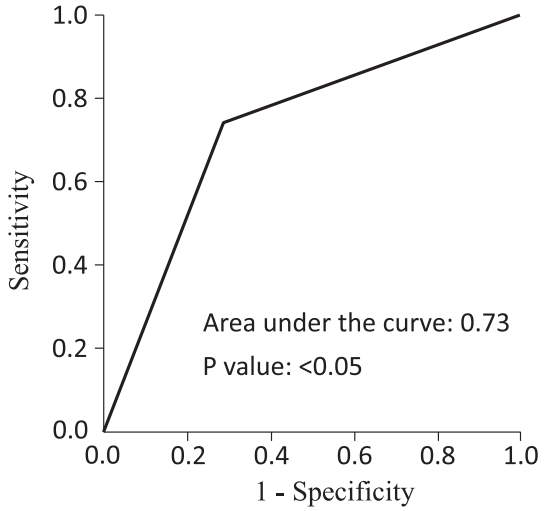

Fig. 1. Receiver operating characteristic curve for unaffected grip strength on the Stroke Impairment Assessment Set.

Materials and Methods

This was a retrospective observational study in which data collected from the medical records of previously-discharged patients were analyzed. This study carried out at North-Fukushima Medical Center. The institutional Ethical Review Board of North-Fukushima Medical Center reviewed and approved the content of this study (No.56).

The subjects were stroke patients who were hospitalized in the hospital's convalescent rehabilitation ward between October 2012 and December 2014. The inclusion criteria were having no significant cognitive dysfunction (a score of at least 21 points in the Revised Hasegawa's Dementia Scale), and no missing records of interest variables mentioned below. We categorized the patients who scored at least 6 points for the items of "Toileting" and "Toilet transfer" in the FIM® instrument [8] as members of the independent toileting group; patients in the non-independent toileting group scored 5 points or lower for at least one of these two items. Then, the patients in these two groups were compared for background factors (age, gender, type of stroke, and affected side), unaffected grip strength, and trunk function. Unaffected grip strength and trunk function (verticality and abdominal muscle strength) were evaluated using items from the Stroke Impairment Assessment Set (SIAS) [9] as indices. In unaffected grip strength test, if the grip strength is above 25 kg in two trials, a score of 3 is given. A score of 2 means a strength of 10−25 kg, and a score of 1 is given if the unaffected grip strength is 3−10 kg [9]. SIAS was adopted because it is widely used in the rehabilitation clinical setting and can be completed in a short time. Intergroup comparisons were done using the Student's t-test, Chi-square test, and Mann-Whitney U test. To identify factors strongly associated with the level of toileting independence, logistic regression analysis (forced-entry) was performed using the items that showed a significant difference between the two groups as independent variables, and the groups as dependent variables. In addition, logistic regression analysis (forced-entry) was also performed by adding age, gender, and affected side as independent variables to remove the confounding influence. Taking the small sample size in this study into consideration, age, gender, and affected side were entered one by one. To finish, receiver operating characteristic (ROC) analysis [10] of items that were significant in the logistic regression analysis was performed to calculate cut-off values using the Youden index [11].

Results

The subjects included 37 stroke patients (21 men and 16 women, mean age: 65.7 ± 14.5 years, mean period since the onset of stroke at the time of evaluation: 92.8 ± 38.3 days). The independent toileting group included 23 patients, and the non-independent group included 14 patients. Table 1 presents the results obtained from patients in each group. Intergroup comparisons revealed that significantly higher scores for unaffected grip strength on the SIAS in the independent group, compared to the non-independent group. However, no significant differences were found for trunk function from the SIAS (verticality and abdominal muscle strength). Logistic regression analysis identified unaffected grip

Table 1. Comparison of parameters of the independent and non-independent groups

	Independence (N = 23)	Non-independence (N = 14)	Significant
Age, years	62.6 ± 16.0	70.9 ± 10.1	ns[a]
Men, %	65.2	42.9	ns[b]
Right-side hemiplegia, %	47.8	42.9	ns[b]
Type of stroke			
Cerebral infarction, %	73.9	64.3	ns[b]
Cerebral hemorrhage, %	26.1	35.7	
Time poststroke, days	86.7 ± 37.5	100.1 ± 39.5	ns[a]
SIAS Verticality (0−3)	3 (0)	3 (0)	ns[c]
SIAS Abdominal Muscle Strength (0−3)	3 (0)	3 (1)	ns[c]
SIAS Unaffected Grip Strength (0−3)	3 (1)	2 (1)	$p < 0.05$[c]

Mean ± SD or Median (IQR) or %
Abbreviations: SIAS, Stroke Impairment Assessment Set
[a] Student's t test; [b] Chi-square test; [c] Mann-Whitney test

Table 2. Logistic regression analysis to estimate the independence of toileting

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]	
	Odds ratio	*P* value	Odds ratio	*P* value	Odds ratio	*P* value	Odds ratio	*P* value
SIAS Unaffected Grip Strength	7.08	< 0.01	5.56	< 0.05	12.83	< 0.05	7.06	< 0.05
Age			0.98	0.496				
Gender (0, women; 1, men)					0.438	0.487		
Affected side (0, right; 1, left)							0.851	0.832

Abbreviations: SIAS, Stroke Impairment Assessment Set.
[a] Model 1 into which only SIAS unaffected grip strength
[b] Model 2 into which SIAS unaffected grip strength along with age
[c] Model 3 into which SIAS unaffected grip strength along with gender
[d] Model 4 into which SIAS unaffected grip strength along with affected side

strength from the SIAS as significantly associated with toileting independence (Table 2). This significant association was also maintained after the influences of age, gender, and affected side were removed. The ROC analysis of unaffected grip strength from the SIAS provided a cut-off value of 3 points (sensitivity, 74%; specificity, 71%; ROC area under the curve, 0.730), at which independence was differentiated from non-independence.

Discussion

The results of this study suggest that toileting independence is associated with unaffected grip strength scored using the SIAS criteria. It has already been reported that unaffected grip strength is associated with the independence level of various ADL items including toileting and ADL prognosis in stroke patients [4, 12], and the originality of this study was to calculate the cut-off value associated with the presence or absence of toileting independence. It is assumed that the association between these two variables is attributed to the need for a certain degree of unaffected grip strength for manipulating lower garments. In addition, unaffected grip strength correlates with quadriceps muscle strength, skeletal muscle mass, one-leg standing time, and other factors in the elderly [13], and grip strength on the unaffected side has been found to correlate with the strength of other ipsilateral muscles in stroke patients [14, 15]. Therefore, there is a possibility that unaffected grip strength reflects whole body performance, and whole body performance influences toileting independence. However, these theories remain a matter of speculation. Our results agree with those of a previous study by Bae et al. [4] that describe the relationship between unaffected grip strength and toileting independence in subacute stroke patients; however, there seems to be a slight difference regarding the relationship with the affected side. Bae et al. [4] reported that this relationship is observed only in right hemiplegic patients, whereas our results suggest that the relationship is maintained even after the influences of the affected side (i.e., right and left hemiplegia) are removed. It is thought that the reason for this difference is the influence of the analysis method that the previous study [4] used bivariate analysis whereas

our study performed multivariate analysis. Because bivariate analysis cannot generally adjust the influence of confounding factors, the results of bivariate and multivariate analysis may be different. Further studies are needed to reveal whether the affected side influences the relationship between unaffected grip strength and toileting independence.

No association was seen between toileting independence and trunk function in the present study. Earlier studies have reported that trunk function is associated with toileting abilities [5−7]. The difference between the results of the present study and those of earlier studies can be explained by the patients in the present study who scored nearly full points for the verticality and abdominal muscle strength items in the SIAS. This could have produced a ceiling effect that prevented detecting an association with toileting independence. Therefore, the results of the present study do not rule out an association between toileting independence and trunk function. This means the relationship between unaffected grip strength and toileting independence and cut-off value indicated by this study cannot deny the possibility of being complicated by functional state of trunk. Therefore, it is necessary to keep in mind that the cut-off value shown in the present study may be applicable to only patients with good trunk function.

In the present study, the calculated SIAS cut-off value of 3 points for unaffected grip strength may be useful for easily estimating toileting independence. Grip strength can be quickly measured regardless of healthcare provider experience (in our experience, it is possible within 3 minutes.). Regarding the accuracy of the cut-off value, a previous study has calculated the cut-off value for toileting independence using BBS [3] and has reported that if 42/41 points for BBS were adapted, ROC area under the curve, sensitivity, and specificity were 0.832, 78%, and 83%, respectively. In contrast, ROC area under the curve, sensitivity, and specificity of our cut-off value were 0.730, 74%, and 71%, respectively. Therefore, the accuracy of the cut-off value calculated in this study may seem to be at a slight disadvantage compared with that of the value calculated using BBS; however, we believe that it is within a practical range and using grip strength saves valuable time over using BBS.

A limitation of this study was that we unintentionally recruited patients who did not have any marked deterioration of trunk function. Further investigations are needed to determine if the cut-off value shown in the present study is applicable to patients with reduced trunk function. Other limitations included the small sample size and limited examination of unaffected grip strength, using only the SIAS. In addition, the subjects were inpatients of a rehabilitation hospital ward. Therefore, generalization of this study's results may be limited. Furthermore, higher brain dysfunction variables (e.g., aphasia, unilateral spatial neglect, apraxia, and attention deficit) and motor and sensory functions of the upper and lower limbs on the affected side were not addressed. Further studies are needed to expand upon these results.

Summary and Conclusions

We examined assessments that could be completed in a short time for measuring toileting independence using the grip strength of the unaffected side and trunk functions in stroke patients. In distinguishing independent and non-independent toileting groups, the cutoff value for the grip strength from the SIAS was 3 points (sensitivity, 74%; specificity, 71%; ROC area under the curve, 0.730). Grip strength can be quickly measured regardless of healthcare provider experience, and the calculated cut-off value may be useful for easily estimating toileting independence.

Conflict of interest

There are no conflicts of interest to declare.

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Sky Mirror Model: A Fusion Model of Therapeutic Use of Self for Occupational Therapy Practice

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Abstract: This paper articulates for the first time an Asian-Western fusion model of therapeutic use of self for occupational therapy practice. The Sky Mirror Model synthesizes concepts, metaphors, and praxes from Asian and Western cultures. Metaphors of sky and mirror form the epistemic receptacle for a set of twelve therapeutic factors. A case study illustrates the interplay of key factors as the therapist embodies and enacts the 'sky mirror' in the fluid dance of a therapeutic relationship with the client. Sky Mirror Model's paradigm of unconditioned being and therapeutic presence is counter-hegemonic, radically different, and intimately linked to the psychospiritual integration frame of reference.

Keywords: Metaphor, therapeutic presence, unconditioned being, counter-hegemonic, psychospiritual integration

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Introduction

Therapeutic use of self is a concept that has received little attention in occupational therapy literature and low prominence in occupational therapy education curriculum [1, 2]. This is despite the finding that occupational therapists surveyed regarded therapeutic use of self as central and important to the occupational therapy process [3]. In the same survey, occupational therapists indicated that while they highly valued therapeutic use of self as a core skill, their formal occupational therapy education did not provide them sufficient training in this key area. Theoretical and published information was sparse and practical training in therapeutic use of self was more incidental than intentional. As a result, most occupational therapists surveyed did not feel adequately prepared in the skills on therapeutic use of self.

Various occupational therapy scholars have attempted to define therapeutic use of self. Punwar and Peloquin [4] proposed that therapeutic use of self on the part of the therapist is the "… planned use of his or her personality, insights, perceptions, and judgments as part of the therapeutic process". Taylor [2] in her Intentional Relationship Model envisioned therapeutic use of self as the ability to flexibly apply six modes of practice or interpersonal skills comprising advocating, collaborating, empathizing, encouraging, instructing, or problem solving with the client at the appropriate time and depending on need. Kielhofner and Forsyth [5] in the Model of Human Occupation detailed a set of therapeutic strategies that can be construed as elements of therapeutic use of self in facilitating client occupational performance – validating, identifying, giving feedback, advising, negotiating, structuring, coaching, encouraging, and providing physical support. In the Canadian Model of Client-Centred Enablement, Townsend et al. [6] highlighted a set of ten key enablement skills – adapt, advocate, coach, collaborate, consult, coordinate, design/build, educate, engage, specialize – which are relevant to therapeutic use of self. There is a certain degree of overlap among the three models articulated thus far, even as they attempt to provide a map of facilitating or enabling occupational performance in the context of a therapeutic relationship.

A common thread or ethos that runs through these models is that of intentional, strategically-directed, therapist-initiated activity or skill. All the modes, strategies, and enablement skills of the Intentional Relationship Model, Model of Human Occupation or Canadian Model of Client Engagement respectively can be seen to pertain to the occupational therapist's doing and becoming. That is, these models seem to be talking about what the

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occupational therapist actively does (e.g. advocating, advising, and coordinate) in the interaction between therapist and client, and thus what he/she becomes in the process of doing (e.g. role of advocate, advisor, and coordinator).

The Sky Mirror Model of therapeutic use of self is a fusion of Asian and Western cultural metaphors, concepts, and praxes (theory-informed practice). It draws on cultural images of mirror and sky ubiquitous in Asia. Metaphors of mirror and sky have profound connotations of inner clarity, stillness, openness, presence, and insight. As such, they fit well with the overarching emphasis of Sky Mirror Model on the being of an occupational therapist. This model articulates therapeutic use of self in terms of the occupational therapist's being, both its inner dynamics and its mutuality with the being of another.

Sky mirror as core metaphor

The work of Iwama [7] underscores the centrality of cultural assumptions and metaphors in construction of occupational therapy theory and practice. Occupation-centred models of practice and current articulations of therapeutic use of self in occupational therapy are themselves culturally bound and historically located. Globalization of goods, services, and knowledge has created an impression of universalized knowledge categories and metaphors stemming from Anglo-American culture. Hammell [8, 9] pointed out that such universalized knowledge is naturalized to the extent that it is seen not as cultural artefact but as unproblematic universal truth. For example, occupational science claims to espouse a set of universal 'truths' about human occupational nature, essentiality of occupation, the incontrovertible link between autonomy, occupation, and health, and other related ideas. Research evidence is summarily gathered to render support to such ideas, through various qualitative or quantitative methodologies. Yet, implicit assumptions and ideological commitments that serve to underpin and construct notions of evidence and methodologies remain assumed rather than questioned. Tacit but powerful metaphors hidden beneath our construction of knowledge remain unexposed.

In this regard, the Sky Mirror Model is constructed from a fusion of both Asian and Western metaphors, concepts and praxes. This is seen in the model's core metaphors of "sky" and "mirror" as well as the set of therapeutic factors within its four domains. As core metaphor, "sky" is a meaningful cultural image within Asian cultures – particularly Indian, Chinese, Vietnamese, Japanese, and particularly Himalayan cultures like Tibet and Nepal [10−15]. The salience and prominence of the sky metaphor in Himalayan cultures may be linked to geographical and climatic factors distinctive to these territories.

Across these cultures, the sky is a powerful symbol for the vast, open, luminous nature of the mind that perceives and cognizes all sensory and psychological data in a free-flowing, non-fixated, non-concretizing way [16, 17]. In particular, the sky is seen as an immaculate expanse akin to awareness as a centerless clearing through which one's unique life history flows, just as clouds might flow through the vast open sky without centre or circumference. Ontologically, awareness or consciousness or mind is *open* because it is free of concretized identity [18]; *luminous* because myriad appearances manifest in awareness; and *knowing* because it is able to cognize or know whatever appears in consciousness [19]. Phenomenologically, realizing this sky-like nature of awareness is a state of peace and joy with absence of inner affliction and conflict. This lack of reactivity also means presence of dynamic responsiveness to the anguish of others. Thus, the sky metaphor is a metaphor rich in meaning in Asian contexts [20, 21].

The core metaphor of mirror is another cultural image in Chinese, Japanese, Indian, and Himalayan cultures. In these Asian contexts, the mirror's ability to reflect things as they are unbiasedly symbolizes the ability of awareness to cognize all phenomena without reactivity. The mirror's reflective capacity is based on it being still, simple and clear, free of dust and dirt. Even as the mirror reflects, it remains unstained in any real or permanent way. Similarly, mirror-like awareness reflects things as they are, without embellishment or detraction, and without being permanently stained in any way [22]. Hence, as cultural metaphor, the mirror is highly relevant to how a therapist is present in his/her therapeutic relationship – still, simple, clear, non-reactive, non-judgmental, and reflecting client issues, needs, and values without bias.

Taken together, the metaphor of 'sky mirror' can be understood as sky reflected in mirror as well as mirror reflecting in the sky – both of which convey the implications of therapeutic presence focused less on *doing* and more on *being*. This focus on *being* a wise therapist skilled in healing bears resonance with a pervasive ancient meme of Asia – that of a sage, awakened being, and realized soul [23, 24]. From Sky Mirror Model's perspective, a therapist's use of self is not so much a deliberate concocting of a 'therapeutic personality' replete with a collection of 'highly desirable skills' that when enacted conduces to positive therapy outcomes. Rather, Sky Mirror Model advocates an approach to therapeutic use of self that has as its core the power of therapeutic presence – uncontrived and unmerited,

neither performance-driven nor outcome-focused, but spontaneously manifest and focused on the present-moment. The qualities represented by the sky and mirror as previously discussed, when taken together, coalesce into a picture of spontaneous, present-moment, uncontrived therapeutic presence that is powerfully healing in non-self-conscious ways.

Congruent with its part-Asian roots, Sky Mirror Model focuses on the priority of *being* over *doing* and *becoming*, where the latter two are regarded as outflows of the former. The priority of being can be seen in multiple discourses and praxes of Asia that at various points in history have intermingled and co-constituted the spirit of the Asian worldview. These discourses and praxes include those of Buddhist, Confucianist, Taoist, and Hindu origins, and their diverse inter-fusions and combinations (e,g, confluence of Buddhist and Taoist ideas in Chan/Zen).

Being is not the exclusive domain of Asia, as evidenced in the philosophies of Heidegger and Gadamer of the existentialist-hermeneutic tradition, and the influential theology of Torrance in the biblical tradition [25−27]. Heidegger's notion of the primordiality of *dasein* in human experience [25] and Torrance's pivot on the outflow of doing from the fullness of being [26] are important ideas salient to Sky Mirror Model. Sky Mirror Model is one that vocalizes and reclaims a practical concept marginalized in modernity's and occupational therapy's accentuation of activity over restedness, becoming over being, extroversion over introversion, speed over slowness, profit over people, and productivity over fruitfulness.

A fusion model?

Sly Mirror Model's therapeutic factors illustrate the fusion of Asian and Western concepts and praxes. The organization of these factors into four domains is a theoretical move embedded in Western conceptual differentiation and structuralism. The structure of a model in terms of its component parts and how they are organized is a case in point. Sky Mirror Model's four domains of the cognitive, affective, attentional, and conative are derived from Western psychological science. Among the factors identified and included under these domains, about half derives from Western intellectual traditions while the other half derives from Asian wisdom cultures (see Table 1).

In particular, factors of flexibility of consciousness, three-tracked mind of clinical reasoning, knowledge of models in context, presence, genuineness, and humour derive from Western clinical and therapeutic traditions. Factors such as mindfulness, acceptance, attentional balance, presencing, compassion, and empathic attunement derive from Asian wisdom traditions such as Buddhism, Taoism, and Yoga [16, 23, 28−32]. Without overstating the different cultural origins of the two sets of factors, it is evident that cultural difference and fusion are implicit in their conceptualization. For instance, without the fertile encounter between Western psychology [33] and behavioural medicine [34] with Buddhism, concepts and practices of mindfulness (Pali: *sati*; Sanskrit: *smrti*) would not have been promulgated in Western scientific literature and assumed prominence in academic and professional discourse.

Domains and factors of sky mirror

Sky Mirror Model privileges therapeutic presence as the essence of therapeutic use of self, where *becoming* does not create one's being but is rather a natural outflow of the fullness of *being*. Torrance as cited in Molnar [35] spoke of *becoming* expressing the dynamic nature of *being*. In other words, a Sky Mirror Model-inspired therapist ceases striving to become the pre-conceived therapist he/she wants to be by doing more of this or that. Rather, the therapist stops all ego-driven striving, doing, and becoming to rest profoundly in the plenitude of *being* where these four domains of twelve factors can be spontaneously actualized. Without actualizing a fullness of being that overflows, all attempts at doing are at risk of being either contrived or ego-driven, prone to the risk of fatigue and burn-out on the part of the therapist.

Four domains

Sky Mirror Model's cognitive, affective, attentional, and conative domains follow the model of mental

Table 1. Domains and factors of the Sky Mirror Model.

Cognitive	Affective	Attentional	Conative
Flexibility of consciousness	Presence	Mindfulness	Humour
Three-tracked mind of clinical reasoning (+ narrative reasoning)	Genuineness	Acceptance	Presencing
Knowledge of models in context	Compassion	Attentional balance	
	Empathic attunement		

balance articulated by Wallace and Shapiro [36]. The cognitive domain pertains to the processes of thinking and cognizing – how we think, analyse, problem solve, construct, synthesize, recall and so forth. The affective domain pertains to emotional processes – what and how we feel, react, respond to things. The attentional domain pertains to the capacity of the mind for focusing, sharpening, clarifying, broadening, and deepening attention. The conative domain is the realm of intention and will, the exercise of volition and choice.

Twelve factors

Sky Mirror Model's therapeutic factors synergize and synchronize to elicit therapeutic use of self that is skilful and efficacious. The organic and harmonic orchestration of these factors is not subject to volitional control or manipulation of the therapist. They are not viewed as concrete skills to be gained but creative abilities that emerge out of deep 'self-forgetful' restedness in being [37, 38].

Cognitive domain

The cognitive domain is the discursive and inferential aspect of mental functioning that contributes to therapeutic use of self. The first cognitive factor of flexibility of consciousness is the ability to shift flexibly from one frame of reference to another, traversing multiple paradigms in an open, fluid and creative way [39, 40]. Such flexibility of consciousness confers upon the therapist the freedom to adopt non-dominant and alternative perspectives to familiar or intractable problems. Instead of being fixed on one point of view or fixated on one ideological agenda, the therapist has the freedom to seamlessly enter the lifeworlds of their clients.

The second cognitive factor is three-tracked mind of clinical reasoning [41]. The first track is procedural reasoning, which is solution-focused thinking that targets specific problems. The second track is interactive reasoning, which seeks to build positive therapist-client relationships and promote collaborative problem identification and problem solving. The third track is conditional reasoning, which integrates procedural and interactive reasoning to respond to changing situations and predict possible client futures. To these three tracks of reasoning can be added narrative reasoning, the form of thinking that "… make[s] sense of people's particular circumstances of the client; prospectively imagine[s] the effect of illness, disability or occupational performance problems on their daily lives; and create[s] a collaborative story that is enacted with clients and families through intervention" [42]. Taken together, these forms of clinical reasoning allow the therapist to assess the client's occupational performance and participation in order to best enable it.

The third cognitive factor is knowledge of models in context [7]. This is the ability of the therapist to contextualize and personalize various conceptual practice models of occupational therapy to the unique life situation, needs, cultural background, values, and history of the person seeking therapy. In particular, culturally safe and competent practice involving reflexivity, awareness (both self and cultural), and cultural sensitivity on the therapist's part is crucial to efficacious therapeutic use of self. Such culturally competent practice has the potential to help the client "… reach a higher plane that is meaningful to the client's particular worldview and sphere of meanings" [7].

Affective domain

The affective domain is the locus of our emotions and feelings as we react or respond to events of our life situation. The affective factors of presence and genuineness are salient to how and the extent to which therapists are emotionally available to the clients they serve. Presence means being fully there for another human being, not emotionally withdrawing or isolating from a person without any justifiable reason [43, 44]. Genuineness is the ability to be real and transparent, not hiding one's flaws or holding hidden agendas, to the extent of being willing to appear vulnerable [43, 45]. Thus, genuineness is the courage to be human with all its failings, weaknesses, and vulnerabilities.

Compassion is the sense of active caring for another who is suffering and the desire to alleviate that suffering [31]. Compassion can extend to others who are suffering and also to oneself. Self-compassion is the caring of oneself and attentiveness to one's own suffering without self-condemnation or judgment [32].

Empathic attunement is the availability and capacity to track the emotional ups and downs of another person, staying close to them in their deeply personal and often difficult emotional journey [43, 45]. Empathic attunement requires an emotional maturity and stability that creates an interpersonal space of attunement that is itself a healing experience.

Attentional domain

The attentional domain comprises factors of mindfulness, acceptance, and attentional balance. Mindfulness is defined as moment-by-moment attention to present experience that is intentional, non-judgmental, and purposeful [34]. As such, mindfulness confers a meta-perspective to experience, allowing for a less reactive and more constructive relationship to persons, things, and events [47]. As present-moment attention, mindfulness counteracts cognitive fusion – the identification

of awareness with its content (i.e. concepts, thoughts, and verbalizations) such that the immediacy of present moment experience is lost. Mindfulness enables cognitive defusion and recapturing of experiential immediacy [46, 47].

Acceptance is corollary to mindfulness, following the approach of Acceptance and Commitment Therapy [46]. Acceptance is openness to experience in all degrees of pleasantness or unpleasantness. It is the antithesis of experiential avoidance – the pathological resistance to and avoidance of difficult unpleasant emotional experiences [46]. By opening to challenging emotions through acceptance, one can fully acknowledge one's humanity and dedicate oneself to valued life goals without paralysis of fear or avoidance.

Attentional balance is a rare and exquisite state of mental stillness, clarity, pliancy, and joy brought about by skilled relaxed focusing of attention for prolonged periods [16, 17, 23]. There exists various depths of attentional balance ranging from initial unified attention for four hours at a stretch to profound cognitive unification beyond sensation of time, place, and person for as long as one wishes. Attentional balance is a contemplative skill that can be mastered by any dedicated practitioner [48]. Once established, attentional balance confers upon the practitioner an exceptional degree of psychological wellbeing, with benign effects on physical wellbeing [23].

Conative domain

The conative domain comprises two factors, humour and presencing, that relate to intentionality and choice. Conscious surrendering of will and choice in the spontaneous bursting forth of humour, though not an act of wilful choice per se, is a dynamic expression of conation. In humour, it can be said that the controlling will is released into a field of open spontaneity where playfulness can arise [49, 50]. Vergeer and MacRae proposed that humour has multiple facets that include the balancing and transforming of negative emotions, grounded in spontaneity, and conveying empathy and honesty as part of therapeutic use of self [51].

Presencing is the intentional quietening of heart, mind, and will so to be fully present to the moment and to sense acutely the dynamics, possibilities, and potentials of the emerging future. Presencing as a concept comes from leadership theory and is a way of leading from the future as it emerges [30]. It aims to address the blind spot of leadership found within the inner state of the leader himself/herself. As such, presencing involves a profoundly quiet heart, mind, and will sensitized to stirrings in the field of present and future possibilities. Presencing resonates with the concept of wisdom as higher order metaperspectives and transperspectival "pure awareness" where multiple angles of viewing the world are celebrated [52].

Applied to the process of occupational therapy, presencing takes the form of co-entering the shared therapeutic space of conative silence with the client, so as to birth a vision for future occupational fulfilment. A 'prototype' of this occupationally fulfilled future can be designed and built collaboratively by client and therapist, inviting further iterations as new facts come to light. Presencing as a therapeutic factor thus serves as a powerful force for recrafting an occupational life after illness, disability, displacement, or disruption.

Case example: Dancing the sky mirror in practice

A case example will illustrate the dance-like interplay of all therapeutic factors across the four domains of Sky Mirror Model. Here, the therapeutic process is undergirded by the uncontrived *being* of the therapist – a centreless clearing through which the unique life history of the therapist flows and where all thoughts, emotions, sensations, colours and sounds are seen as displays of awareness much like paintings in the sky. Fenner and Wallace, speaking from within an Asian cultural worldview, advocate just such a state of uncontrived being [17, 24, 38]. From this perspective, the therapeutic factors spontaneously actualize out of the unbounded centreless clearing of awareness as wisdom that responds organically to the needs of the client.

Introducing James

James (not his real identity) was an entrepreneur in his late forties who had experienced a recent depressive episode, had overweight issues linked to diabetes, and had undergone a divorce and business liquidation. At the time of first consultation, James had just started a second business as a solo entrepreneur, which was a huge stepdown from his previous company of about 150 staff. He was having communication challenges with his ex-wife around child custody matters and struggled with finances due to minimal income from his business. He had referred himself to occupational therapy through an information brochure he picked up.

Dancing the Sky Mirror

Occupational therapy began with James and the occupational therapist collaboratively identifying and prioritizing James's occupational performance issues. This was a challenging process at first as James was experiencing strong resistance to contacting the painful memories and thoughts of his current life situation at

that point in therapy. He had an ambivalence of desiring therapy on one hand and resisting the therapeutic process on the other. Therapeutic use of self at this point was focused on being an *effortless openness and centreless clearing* for the unique life world of James to flow and intersect with the unique life world of the therapist. In the up-close and personal encounter of two life worlds, cradled in the centreless clearing presenced by the therapist, dense knots of thought and emotion were laid bare and released in the dialogical space that opened up [14, 21].

Presence and genuineness as described by Elliot, Watson, Goldman, and Greenberg [43] on the therapist's part reassured James that the therapeutic space was free of judgment and false pretences – that the therapist was truly and honestly available to him by being willing, vulnerable, and fully there. *Mindfulness* – the capacity to abide clearly and sharply in present-moment experience without reactivity [33, 34] – coupled with *acceptance* of the many surging waves of emotions in the therapist allowed for a non-defensive, warm and sincere emotional availability to James [43, 46]. Synergy of mindfulness and acceptance was essential for the therapist in embracing emotional reactions triggered by James's defensive and at times aggressive remarks.

The therapist's natural *compassion* for James as he journeyed through his painful life situation enriched and infused the moment with a supportive, safe, and healing ambience. The therapist's self-compassion and compassion for James concatenate to enable such ambience [31, 32]. In the synchronous co-synergy of these therapeutic factors within the expanse of the therapist's 'sky mirror' awareness, a gradual and profound shift began to occur in James. He began to relax into the moment, became less fixated on and defensive around his emotional issues, and became more willing to contact his present-moment experience of past hurts and disappointments.

Cognitively, the therapist's *three-tracked mind of clinical reasoning* was central to the occupational enablement process [41]. For the initial phase of therapy, *interactive reasoning* took centre-stage in the foreground with procedural reasoning and conditional reasoning in the background. As James became more emotionally, cognitively, and attentionally engaged in the therapy process over time, *procedural reasoning* in collaboration with James to identify and prioritise occupational performance issues became prominent. *Conditional* and *narrative reasoning* were employed as therapy focused more deeply on the changing circumstances of his life [42]. Collaboratively, we engaged in occupational storying of his life and occupational reconstruction of a preferred future. Threads of his past and present were woven together with threads of his passions, interests, values, previous knowledge and expertise, emerging worldview, sense of the sacred, and recent spiritual experiences into a compelling vision of his future occupational self and world.

Flexibility of consciousness played a key role in the process of occupational storying and reconstruction. Flexibly adopting various perceptual positions on the part of the therapist enables a more complete appreciation of the client's life world [39, 40]. Taking a *second-person perspective* required meta-awareness on the part of the therapist – to not be fixated on and lost in the content of the therapist's own consciousness. By entering the client's world through a dynamic flow of awareness away from self to the other, the therapist was able touch a place of mutuality where James's life world mattered and came alive for the therapist. In adopting a *third-person perspective*, the therapist simply observed the dynamics and flow of dialogue as an impartial witness. Taken together, the therapist's ability to enact shifts in perspectives fostered a healthy therapist-client rapport.

After identifying James' occupational performance issues, the therapist selected a suitable frame of reference for working with him. This was done collaboratively with James, taking into account his cultural context, personal inclinations, and choices, and with recognition of cultural boundedness of both therapist and client. This thus exemplifies the therapist's *knowledge of models in context* [7]. In so doing, the therapist considered James's cultural metaphors, worldview, and preferences in conjunction with various frames of reference, which themselves were cultural constructs. For James, issues of spirituality pertaining to life direction, purpose, and spiritual practice were of profound significance to him. He had a cosmopolitan outlook open to the diversity of human cultures, having lived in the city for all his life. He was particularly drawn to Asian philosophies and worldviews. Thus, the Psychospiritual Integration (PSI) frame of reference [53], based on a multi-civilizational perspective, was selected as the occupational therapy approach that best fitted James.

Attentional balance is a state of consciousness with varying degrees of intensity and depth. At its most fundamental level, attentional balance is characterized by mental stillness, simplicity, non-conceptuality, and bliss of physical and mental pliancy [23]. This condition of attentional balance occurs only in the context of deep meditation. Effortlessly focused, alert yet relaxed, the therapist with attentional balance can imbue his/her consciousness with a similitude of that stillness, non-conceptuality, and blissful pliancy in the midst of a therapeutic relationship. In the case of James, the

qualities of attentional balance suffusing therapist consciousness during therapy sessions facilitated unhurried, non-controlling, non-outcome fixated tempo and texture of therapist-client communication.

Attentional balance stabilized and supported the abiding of the therapist in the open transparency of 'sky mirror' awareness. As a result, James was able relax sufficiently to unlearn old habit patterns of cognition and emotion that blocked his life flow. He was amenable to being artfully coached by the therapist to relearn his enthusiasm for life. More than that, he was sufficiently inspired by the therapist's quality of attention to seek meticulous mentoring in the intricacies of meditative practice, which was at the heart of his spiritual journey and practice.

Humour interspersed the therapeutic process and relationship from beginning to the end [49, 50]. When James first attended therapy, he was having difficulties opening up and relaxing into the moment. Adopting a genuine, light-hearted, and playful attitude to each moment on the therapist's part was conducive to placing James at ease. At the same time, it was necessary to be mindful of the appropriate times for humour and for seriousness. There would be times when the therapy session would naturally burst forth in bouts of laughter as both therapist and James shared spontaneous playful humour in the form of stories, anecdotes, jokes, and caricatures.

These moments of therapeutic humour added a touch of grace and lightness to a sometimes emotionally intense therapy process. On one particular therapy session, both therapist and James spontaneously decided to have lunch together instead, enjoying a pleasant ride in James's new sports car. This unplanned event created the opportunity for debriefing of therapy sessions thus far and invited a sense of celebration of James's achievements in spite of various odds. Thus, what began as spontaneous humour became a therapeutic milestone.

Empathic attunement was frequently enacted by the therapist during therapy [43, 45]. This was particularly evident during the initial phase of therapy when many past wounds and present conflicts surfaced for James. In synergy with mindfulness, acceptance, self-compassion, presence, and echoes of attentional balance, the therapist was able to mindfully and empathetically track James' emotional ups and downs. This enabled the therapist to adjust the speed, intensity, rhythm and energy levels of therapy sessions so as pace James's emotions. Connecting with James on a basic emotional level was instrumental to helping James begin the process of inner healing through emotional coaching.

Presencing was a therapeutic factor that became more prominent and salient as therapy progressed [30]. As James grew in self-confidence and spiritual wholeness, he was increasingly focused on specific details of actualizing his occupational vision. There came a time when quietening of hearts, minds, and wills in the ground of silence was beneficial to allow for emergence of creative possibilities. James' growing presence, mindfulness, and attentional balance afforded a conducive dialogical space for presencing to occur.

Conclusion

Sky Mirror Model grew out of a paradigm that privileges, accentuates, and valorizes *being* over *doing* in its ontology and epistemology [10−12, 15, 27]. This paradigm is especially salient in Asian conceptions of truth and knowledge, especially in Buddhist and Taoist philosophies [17, 29]. It is also present in Continental strands of existential and humanist philosophy represented by Heidegger [25]. Biblical theologies of Barth and Torrance as cited in Molnar [35] articulates a paradigm of being as well. Nevertheless, these discourses are marginalized relative to empirical positivist modes of thinking that currently dominate academic space.

Sky Mirror Model offers a perspective and space of mutuality, where both therapist and client co-participate in a profound process of healing, restoration, transformation, and growth. From Sky Mirror Model's point of view, analysis of client occupational performance issues, collaborative goal-setting, treatment planning and implementation, and outcome evaluation are incidental activities that flow from the dynamic and responsive ground of sky-like, mirror-like being. As a therapeutic ground of wise presence, compassion, and skill, such depth and plenitude of being serves as a treasury of therapeutic benefit for all clients and a worthwhile vision of professional growth and consciousness evolution for the occupational therapist.

In line with Sky Mirror Model's paradigm of unconditioned being, therapeutic presence is not so much a skill or technique to be acquired but a breakthrough awareness to be discovered. In connection with this, the PSI frame of reference provides cogent suggestions on how such breakthrough into sky-like, mirror-like awareness can occur: through the enabling process of transmission, instruction, coaching, co-presencing, and immersion in the realms of meta-occupation, non-occupation, and trans-occupation [54]. These processes are not achievements but facets of a seamless organic process of spontaneous actualization of being beyond contrived effort and self-occupied performance [55].

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■ORIGINAL ARTICLE

Occupation-Based Intervention to improve self-awareness in persons with acquired brain injury: A single-case experimental design

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Abstract: Introduction. Many researchers have indicated a need for interventions to improve self-awareness in people with acquired brain injury, but the intervention methods are still in its developmental stage. The purpose of this study was to investigate the effectiveness of an original awareness intervention using a single-case experimental design with each subject's individual occupation. **Methods.** We used the 'alternating treatments design', two types of interventions (ordinary occupational intervention and awareness intervention) were administered 10 times each (a total of 20 interventions) to four subjects. In the original awareness intervention, the subject participated in activities with self-prediction and self-evaluation before and after participating in activities and a therapist assists them to reinforce appropriate strategies. The Japanese version of the Self-Regulation Skills Interview (SRSI) was administered after each occupation experience, scores and responses for each of the ten interventions were compared between two interventions. **Results.** Three of the four subjects showed significantly lower SRSI scores in the awareness intervention that indicated their awareness were higher than the ordinary intervention and the details of their responses also indicated higher awareness during the awareness intervention. One subject who showed the lowest score of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) in the subjects didn't show any major change. **Conclusion.** The results would suggest the effective of the awareness intervention. Future studies require a larger number of subjects, and investigation of the necessary level of subject's cognitive functions.

Keywords: brain injury, occupational therapy, self-awareness, strategies

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Introduction

People with acquired brain injury often lack self-awareness, often making it difficult for them to recognise the compensatory strategies needed for performing occupations and how to apply these strategies to acquire occupational skills [1–4]. Importance had been placed on intervention that was focused on self-awareness, often using methods had been designed to educate the subject about his or her deficits directly. However, this type of intervention has been criticised for causing the subject to lose motivation for the intervention or the subject's sense of self-efficacy to decline [3, 5, 6]. Thus, in recent years there has been increased focus on intervention methods that help the subject acquire self-awareness on his or her own initiative through the experience of occupations [7–9]. These interventions are designed so that the subject anticipates possible mistakes prior to the start of the occupation and after the completion of the occupation, reviews whether those anticipated mistakes were accurate [3, 4, 9]. Some previous studies on this type of intervention method have used a single-case design [4, 10–12] but there is not sufficient evidence to indicate that self-awareness is adequately improved. Furthermore, many studies have followed a single-case design, there is a need to collect data from more experimental design studies [13].

In previous studies, subjects have anticipated possible mistakes and strategies by themselves, but we thought it was often difficult for subjects to review mistakes appropriately and plan appropriate strategies [1, 2,

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9, 14]. It was reported that subjects overestimated their ability to perform tasks and did not significantly change their ratings after the task experience [14]. So we considered that a more effective method would be one in which subjects attempt self-prediction while in addition the therapist proposes and reinforces appropriate strategies at the same time. Furthermore, it was reported that interventions using errorless learning rather than trial-and-error are more effective [15]. We considered it better for subjects to review occupational experiences in which errors had been prevented by reinforcing strategies rather than to review errors they made. So we would propose an original awareness intervention in which subjects anticipate mistakes and a therapist assists them to reinforce appropriate strategies prior to undertaking tasks; after completing their tasks subjects review their performance.

The purpose of this study was to investigate the effectiveness of an original awareness intervention using a single-case experimental design with each subject's individual meaningful occupation.

Methods

Subjects

The subjects were outpatients at a medical institution who satisfied the following criteria: (a) diagnosed by a physician as brain injury, with the onset of symptoms at least one year previously; (b) identified in medical records and assessment as having impaired self-awareness; (c) physically able to perform the occupations; (d) possessed sufficient linguistic ability to allow responses to questions and instructions; and (e) provided their consent to participate in this study.

Procedure

General data collection. We collected data on age, sex, medical history, and neuropsychological assessments. We gathered data on each subject's daily routines and former lifestyle via interviews with family members, and data on regarding their habitual occupations and the occupations they were interested in.

Pre-intervention assessments.

Neuropsychological assessment. We used two types of assessment: The Japanese Version of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III: [16]) and Rivermead Behavioural Memory Test (RBMT: [17]). The WAIS-III assesses a wide range of general cognitive abilities. It's Verbal IQ and Performance IQ scores are measures of information processing ability via language and visual input, respectively. These two scores are used to calculate the Full-Scale IQ. The mean IQ score is set at 100.

The RBMT assesses the memory functions required to complete activities of daily living. Its Profile score (*maximum 24 points*) is calculated from the raw scores of three stages for each item, and the Screening score (*maximum 12 points*) is calculated from awarding 0 or 1 point in accordance with the standards of each item. The test has cut-off points for different age groups.

Assessment of self-awareness. Self-awareness was assessed using three types of assessments: an Awareness Questionnaire (AQ: [18]), a Japanese version of the Everyday Memory Checklist (Memory Checklist: [19]), and a Japanese version of the Self-Regulation Skills Interview (SRSI: [20]).

The AQ is composed of 17 items related to movement, sensory perception, cognition, behaviour, and emotions. Subjects and others (such as the caregiver and therapist) estimate subject's abilities on 5-point scale (*from* '*poor*'*, 1 point, to* '*very good*'*, 5 points*) as compared to the premorbid condition. The larger the difference between the two scores, the greater the self-awareness impairment.

The Memory Checklist assesses the frequency of episodes in daily life in which the subject has problems related to memory using 13 items. Subjects and others (such as the caregiver and therapist) estimate subject's abilities on 4-point scale (*from* '*Not at all*'*, 0 points, to* '*Always*'*, 3 points*). The larger the difference between the two scores, the greater the self-awareness impairment. In this study, the AQ and Memory Checklist were scored by the subjects and by occupational therapists who knew the subjects well, yet with no other involvement in the research. The attending therapists had at least 15 years' experience in practise the rehabilitation of people with acquired brain injury.

The SRSI is the Japanese-language version of the original SRSI [20]. The following six items were investigated through interview questions: 1. problems that arise in the subject's daily life (emergent awareness), 2. the environment in which the problems arise (anticipatory awareness), 3. the motivation to learn strategies (motivation to change), 4. the generation of strategies (strategy awareness), 5. the use of strategies (strategy use), and 6. the effectiveness of strategies (strategy effectiveness). Responses were assigned scores of 0 to 10 points by a therapist who knew the subjects well, apart from the score for item 3, which was assigned only by the subject him or herself. Higher scores on item 3 indicated greater motivation to change. Lower scores on all other items indicate greater self-awareness. After calculating the scores for each item, we calculated the following three component items: component I (Awareness of difficulty), which comprised the mean scores for items 1 and 2, component II (Motivation to change),

which comprised the score for item 3, and component III (Awareness of strategy), which comprised the mean scores for items 4 to 6.

Choice of individual occupations used in this intervention. Based on the results of interviews, the principal author (the 'researcher') discussed with each subject the occupations associated with their interest and habit in order to acquire self-awareness and become motivated through comparing the occupations to their premorbid abilities.

Implementing the intervention following the single-case experimental method (Fig. 1). Of the various single-case experimental methods, we used the 'alternating treatments design' to avoid continuing one intervention for a long period. We established two times of baseline to assess the subject's baseline occupation abilities without presuming any strategies. Based on these results, the researcher estimated strategies appropriate to the task of accomplishing the occupation. After the baseline, we started two types of intervention: the Ordinary Intervention and the Awareness Intervention. One baseline and intervention period was performed each week, lasting between 40 and 60 minutes.

Analysis of the results.

Subject characteristics. We showed the subjects' general data and neuropsychological assessment and self-awareness assessment in a Table.

The intervention results.

Quantitative analysis: *Comparison of the SRSI scores derived from the ordinary and awareness interventions*. We calculated The SRSI component scores for each intervention. We compared The SRSI component

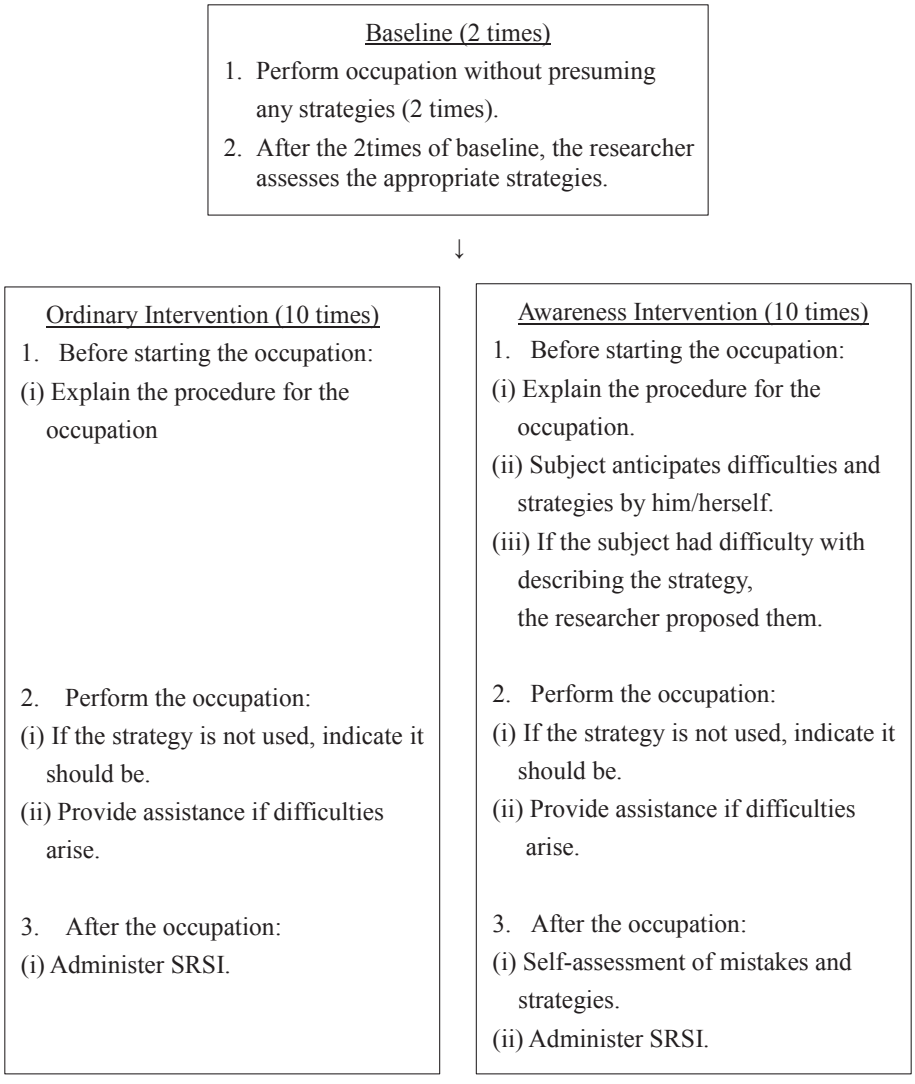

Fig. 1. Procedures for the two types of intervention.
SRSI = The Japanese Version of the Self-Regulation Skills Interview. At baseline, the occupation was performed twice. Subsequently, the two types of intervention were alternated, with each performed 10 times, 20 times in total (in accordance with the alternating treatments single-case design). Both interventions utilized the same occupation and strategies.

I to III scores for each of the ten interventions between the Ordinary and Awareness Interventions using the Wilcoxon t-test. All tests were two-tailed with the standard of significance set at $p < 0.05$. The statistical analyses were performed with IBM SPSS Statistics v 21.0J software.

Qualitative analysis: *Comparison of the SRSI responses from the Ordinary and Awareness Interventions*. We subjected to qualitative analysis of the SRSI responses.

We compiled the statements made as part of component I (Awareness of difficulty) and component III (Awareness of strategy) in verbatim form, divided into the smallest units with meanings, and classified into category units with similar meanings. Then we compared two interventions to discover how many times each category was verbalized. We didn't analysed Component II (Motivation to change) because this item was not part of the interviews; instead, the subjects used a self-rating scale to conduct self-analysis.

To improve the validity of the analytical results, we calculated The SRSI component scores and created categories by two experienced therapists, the researcher and a therapist who was not involved in this research and had practised the rehabilitation of people with acquired brain injury for more than 10 years. In cases in which we were unable to agree on the details of a category, we discussed the issues and continued the analysis until no major differences in opinion remained.

Ethical considerations. Before commencing this study, the researcher provided the subjects with written descriptions of the purpose of the study and obtained written consent from each subject. The written descriptions included the following three points. 1. The researchers would consider both the psychological and physical aspects of the subjects during their participation in the study. 2. When results were published, no data that could identify the personal information would be used. 3. The subjects could withdraw from the study at any time, and their withdrawal from the study would not result in any disadvantage to them. This study was conducted with the approval of the Ethics Committee of the Graduate School of Health Sciences of Hiroshima University (No. 0901).

Results

Subject characteristics (Table 1)

Four subjects (four men, age range: 43–64 years) met the inclusion criteria. The period since onset ranged between 3.4 years and 14.0 years.

The RBMT results indicated that Subject A and Subject D had severe memory impairment. The WAIS-III results indicated that Subject D's Verbal IQ and Performance IQ scores were pretty below average. Subject B's Full-Scale IQ scores were average, but the Perfor-

Table 1. Subject characteristics, scores on Neuropsychological tests and self-awareness assessments.

Subject	A	B	C	D
Age	62	43	48	64
Gender	Male	Male	Male	Male
Diagnosis	Encephalitis	Traumatic brain injury	Cerebral hemorrhage	Traumatic brain injury
Time since injury (years)	4.0	14.0	3.4	8.0
RBMT				
Profile score (cut off score)	8/24 (15/16)	16/24 (16/17)	20/24 (16/17)	8/24 (15/16)
Screening score (cut off score)	2/12 (5/6)	7/12 (7/8)	8/12 (7/8)	2/12 (5/6)
WAIS-III				
Verbal IQ	96	105	99	88
Performance IQ	102	92	113	88
Full-Scale IQ	98	100	106	87
AQ (score difference)	24	0	14	19
Memory Checklist (score difference)	−23	−9	−22	−16
SRSI				
I (Awareness of difficulty)	10.0	9.0	9.0	8.5
II (Motivation to change)	1.0	10.0	0.0	3.0
III (Awareness of strategy)	10.0	9.0	8.0	8.5

Notes. RBMT = The Japanese Version of the Rivermead Behavioural Memory Test; WAIS-III = Wechsler Adult Intelligence Scale-Third Edition; AQ = Awareness Questionnaire. AQ and Memory Checklist, Larger difference between the subjects and others scores indicated lower self-awareness. SRSI = The Japanese Version of Self-Regulation Skills Interview.
Higher scores on component I and III indicated lower self-awareness.
Lower scores on component II indicated lower motivation to change.

mance IQ score was lower than the Verbal IQ score. The AQ results indicated that three of the subjects (excluding Subject B) tended to have high estimates of their own abilities, and that all four subjects had high estimates of their memory function on the daily memory checklists. The SRSI results indicated that, according to component I (Awareness of difficulty) and component III (Awareness of strategy), all four subjects scored between 8.0 and 10.0, indicating a marked impairment. In the results for component II (Motivation to change), Subject B scored 10, indicating a high degree of motivation to learn coping strategies, whereas the other subjects scored between 0.0 and 3.0, indicating a low degree of motivation.

Occupations used for each subject

Subject A indicated the need to be able to organise his schedule. As he was unable to utilise compensatory procedures effectively, we determined the occupation using a paper of instructions as a compensatory procedure. We focused on his strong interest in cooking, and as his intervention time was short, established cooking preparation as his occupation. The following three tasks were to be performed each time: creating a recipe, removing the utensils required for cooking from the shelf, and creating a list of ingredients to give to the researcher. The procedure for the occupation was indicated in the paper of instructions, and the subject completed the occupation in accordance with the instruct paper. The following three strategies were determined: 1. Putting a tick in the appropriate box after completing each task. 2. Reading the tasks listed in the instruct paper aloud before beginning the task. 3. Setting an alarm to make sure he did not forget to give the ingredient list to the researcher.

Subject B was told by his employer that he was unable to perform occupations accurately and that he needed to be taught repeatedly how to do them. He therefore practiced performing occupations accurately using notes. Prior to his injury, he worked with electric power lines; as he was good at occupations that involved measuring. So the occupation involved measuring the floor dimensions of a space approximately 4 m^2 in area and accurately recording the figures. The following three tasks were his strategies: 1. Reading the figures on the measure aloud. 2. Taking notes each time he measured a location. 3. Once finished, checking to make sure his figures were correct.

Subject C habitually used a schedule notebook, but as he did not record enough information, he often forgot appointments. He therefore practised accurately recording detailed information. Prior to his illness, his work involved posting advertisements on the Internet. His occupation therefore consisted of conducting approximately 15-minute Internet searches and recording these searches in detail. The following two tasks were his strategies: 1. Taking notes contents each time the search page changed. 2. Taking detailed notes of the details he found.

Subject D presented marked memory impairment and he was unable to utilise compensatory procedures effectively. Thus, his occupation consisted of performing multiple tasks using a paper of instructions. Prior to his injury, he often went out driving. His occupation was to write down the roads he would drive on to reach destinations he visited in the past using maps, calculating the required highway tolls and creating a drive plan. The following four tasks were his strategies: 1. Putting a tick in the appropriate box once a task was completed. 2. Reading the tasks listed in the instruct paper aloud before beginning, 3. Setting an alarm to make sure he did not forget to give the researcher his completed drive plan.

Results of the interventions

The total of intervention was that Subjects A for 8 months and 21 days, Subjects B for 6 months and 21 days, Subjects C for 6 months and 6 days, and Subjects D for 7 months and 11 days.

Differences between SRSI scores following the two interventions (Table 2).

Component I (Awareness of difficulty). Subjects A, B, and C showed significant differences between their SRSI scores following the two types of interventions ($p = 0.01$ and $p < 0.01$, respectively), showing increased awareness of problems of daily living after the Awareness Intervention.

Component II (Motivation to change). Subjects A and C showed significant differences between their scores for the two types of intervention ($p = 0.02$ and $p < 0.01$, respectively), and they both showed an increased motivation to use strategies after the Awareness Intervention. As Subject B's self-assessment score was always 10 points, there could be no significant differences.

Component III (Awareness of strategy). Subjects A and C showed significant differences between their scores for the two types of interventions ($p = 0.03$ and $p < 0.01$, respectively), and both showed increased awareness of strategies after the Awareness Intervention.

Differences in SRSI responses between the two interventions (Table 3).

Component I (Awareness of difficulty). Subject A's statements were classified into four categories, including 'Nothing in particular' and 'I will forget if it is not written down'. The category 'Nothing in particular' indicate

that he never has considered the problems in his daily life. He made such statements only during Ordinary Interventions and not during Awareness Interventions. The categories 'Forget it if it is not written down' and 'Forget if not told' indicated that he mentioned impaired memory. These tended to occur more frequently during the Awareness Interventions than during the Ordinary Interventions.

Among Subject B's statements some were categorised as 'Nothing in particular' and were seen only during Ordinary Interventions. The categories 'Unable to focus on details' and 'Unable to do multiple tasks simultaneously' indicated he noticed decreased attention and cognitive ability. Such statements tended to be more frequent during Awareness Interventions.

Subject C always made statements categorised as 'Nothing in particular' during Ordinary Interventions. On the other hand, many of his statements during Awareness Interventions were categorised as 'Memory is declining'.

None of Subject D's statements were categorised as 'Nothing in particular'. Although he made statements categorised as 'Tell the same thing repeatedly' and 'Forgets what was said', which referred to impaired memory, he made few statements and there was no clear difference in two interventions.

Component III (Awareness of strategy). Subject A's statements were classified into three categories, including 'Nothing in particular' and 'Take notes'. The category 'Nothing in particular' indicates that he could not make any reference at all for problem strategies and 'Take notes' indicates that he could state specific examples of strategies. During Ordinary Interventions, statements classified as 'Nothing in particular' were made three times and those classified as 'Take notes' were made six times; but during Awareness Interventions, only one statement classified as 'Nothing in particular' was made, whereas those classified as 'Take notes' reached nine times.

Among Subject B's statements, the category 'Nothing in particular' was made only during Ordinary Interventions. The categories 'Check occupations after performing them', 'Take notes' indicated that he could refer to specific strategies and these were made more often during Awareness Interventions. On the other hand, statements that were inappropriate as strategies and were categorised as 'Studies disability in books' and 'Forced to do what he or she was told' were made during both types of intervention.

Subject C's statements were classified as 'Nothing in particular' eight times during Ordinary Interventions and as 'Take notes' twice. During Awareness Interventions, statements classified as 'Nothing in particular' decreased to four and those classified as 'Take notes' increased to six.

Subject D's statements characteristic of him was 'Contents unrelated to strategies', which indicated that responses unrelated to strategies were observed during both types of intervention.

Table 2. Mean and standard deviations for SRSI scores between two interventions.

Subject	Component I (Awareness of difficulty)		*P*
	O I	A I	
A	7.5 (1.5)	6.3 (0.8)	< 0.01**
B	8.3 (0.8)	7.6 (0.6)	0.01*
C	9.8 (0.6)	8.5 (0.9)	< 0.01**
D	8.5 (0.4)	8.2 (0.3)	0.06
Subject	Component II (Motivation to change)		*P*
	O I	A I	
A	5.9 (1.3)	8.5 (0.9)	0.02*
B	10.0 (0.0)	10.0 (0.0)	1.00
C	0.0 (0.0)	6.8 (4.1)	< 0.01**
D	3.5 (1.6)	4.3 (1.4)	0.15
Subject	Component III (Awareness of strategy)		*P*
	O I	A I	
A	8.4 (3.6)	8.0 (1.8)	0.03*
B	8.7 (0.9)	8.6 (1.0)	0.43
C	9.7 (0.6)	8.4 (0.7)	< 0.01**
D	9.0 (0.5)	8.7 (0.7)	0.09

Notes. O I = ordinary intervention; A I = awareness intervention Scores for each of the ten interventions were compared between the O I and the A I using the Wilcoxon t-test, two-tailed.
Lower scores on component I and III indicated greater self-awareness. Higher scores on component II indicated greater motivation to change.
*$P < .05$. **$P < .01$.

Discussion

SRSI score results (Table 2)

Our investigation of SRSI scores indicated that Subjects A, B, and C had significantly lower scores (It means good awareness) for component I (Awareness of difficulty) and subjects A and C had significantly lower scores for component III (Awareness of strategy) during the Awareness Interventions than during Ordinary Interventions. People with acquired brain injury can have a diminished ability to self-monitor in order to modify their behaviour as a result of mistakes [5, 9], so it would be necessary to include appropriate assistance provided by the therapist.

Conversely, although Subject B became more deeply aware of problems in daily life as a result of Awareness Intervention, he did not become sufficiently able to devise appropriate strategies for those problems.

Table 3. Comparison of SRSI statements between two interventions: numbers of Categories after the classification.

Component I [Awareness of difficulty]			Component III [Awareness of strategy]		
Subject A	O I	A I	Subject A	O I	A I
Nothing in particular	4	0	Nothing in particular	3	1
Forget if not written down	5	10	Take notes	6	9
Forget if not told	1	3	Is told by someone	1	0
Become idle	2	0			
Subject B	O I	A I	Subject B	O I	A I
Nothing in particular	2	0	Nothing in particular	2	0
Unable to focus on details	6	7	Check occupations after performing them	1	2
Unable to do multiple tasks simultaneously	2	5	Take notes	1	4
Unable to follow the procedure for the occupation	1	2	Does not think about details	2	1
			Studies by reading books	2	1
			Forced to do what he was told	2	2
Subject C	O I	A I	Subject C	O I	A I
Nothing in particular	10	1	Nothing in particular	8	4
Forget the time	1	0	Take notes	2	6
Memory is declining	0	8			
Poor handwriting	0	1			
Subject D	O I	A I	Subject D	O I	A I
Tell the same thing repeatedly	1	1	Nothing in particular	1	1
Always asks his wife	2	1	Take notes	1	2
Forget what he was told	4	4	Does important thing first	3	5
No sense of meal times	2	4	Contents unrelated to strategy	5	3
In a daze	3	0			

Notes. O I = ordinary intervention; A I =awareness intervention.
The SRSI statements for the two interventions were classified into categories.
The number of times each category appeared were compared between two interventions.
As the numbers of times a category appeared during one intervention were not the same, in some cases the total number of categories exceeds 10.

Subject B had suffered traumatic brain injury and, as shown by his Performance IQ of WAIS-III results, he had diminished information processing and reasoning abilities for specific situations. It has been noted that it is more difficult to gain awareness of a strategy than to gain awareness of problems [9]. The intervention period in this study may be insufficient.

Subject D did not show any change in his awareness of problems or strategies even when Awareness Intervention was used. Subject D had a markedly low Verbal and Performance IQ in his WAIS-III results. Cognitive functions are divided into a seven-step pyramid and self-awareness requires the highest level of all cognitive functions [22]. It is possible that the task of using Awareness Intervention to assess his own performance and talk about himself were too difficult for Subject D.

SRSI responses (Table 3)

The results of our qualitative comparison of SRSI responses indicated that for component I (Awareness of difficulty) and component III (Awareness of strategy), three of the four subjects (A, B, and C) were often unable to verbalise problems and strategies during the Ordinary Intervention, but they made numerous statements of disabilities and appropriate strategies during the Awareness Intervention. As statements classified as 'Nothing in particular' indicated that there was no awareness at all, the results of this study suggest that the intervention method utilised may be effective even for people who, like the subjects in this study, have extremely reduced self-awareness.

Although Subject B's SRSI score for component III (awareness of strategy) showed no significant difference between the two types of intervention (Table 2), he made a larger number of appropriate statements regarding strategy during Awareness Intervention. We considered that this was because during both types of intervention he made inappropriate statements, such as 'Forced to do what he was told', which affected his SRSI score. It has been reported that subjects with brain injuries, especially traumatic brain injuries, have a diminished ability to judge situations [1, 2, 9] and sometimes make statements designed to obscure mistakes to protect themselves [9]. Subject B may have shown a tendency

to obscure mistakes.

Subject D showed no marked change in his statements because of the type of intervention. His statements showed he often changed the topic from his response to the question. This behaviour suggests that the task of reviewing his task and conducting self-analysis was too difficult for him.

Qualitative analysis of SRSI responses brought discovery of awareness that was not reflected in subjects' scores. Based on this, we obtained suggestions as to how to utilize occupational therapy. For example, for Subject B, further research is necessary whether continuing intervention will decrease the number of statements designed to obscure mistakes and increase the number of statements related to failures and appropriate strategies. In addition, for Subject D, we discovered that it is necessary to find interventional methods other than having the subject review himself and talk.

When assessing awareness, it would be more effective to use a method that directly assesses the subjects' statements rather than using only a questionnaire based on the scale.

Usefulness of the tasks undertaken by the subjects (Table 3)

The tasks to be undertaken by each subject in this study were determined based on the subjects' previous habits. Brain injury patients often shift the blame for their failures and mistakes made during occupational therapy [9]. Furthermore, even if patients recognize their failures during occupational therapy, they have difficulty in transferring this recognition to their daily lives [9]. The results of the present study indicate that the subjects recognized their failure of tasks and the strategies employed to accomplish these tasks in the same manner as in their daily lives. In terms of the subjects' recognition of their disabilities, Subject A mentioned "I forget things if I do not write them down," Subject B mentioned "I cannot do multiple tasks simultaneously," and Subject C mentioned "My memory is declining," which signified their recognition of their failures of tasks in their daily lives (Table 3). As for recognition of strategies, subjects A, B and D said they "take notes" and Subject B said, "I check occupations after performing them," as strategies employed during tasks which were recognized in the same manner as in their daily lives (Table 3). These findings suggest that the subjects may have found it easier to recognize their own problems by comparing their present performance with their past performance through undertaking familiar tasks instead of shifting the blame for their failures. This is consistent with the findings of previous studies [4, 9]. However, in this study, the tasks to be undertaken were determined through interviews between the subjects and researchers. Moving forward, tasks will need to be determined using additional standardized methods of evaluation, including the Canadian Occupational Performance Measure.

Limitations and future studies

As this study had only a small number of subjects and the intervention period was short , a future study with a larger numbers of subjects and longer periods of intervention is required . Of the four subjects in the study, one did not show a sufficient effect resulting from intervention. Thus, it is necessary to investigate the level of cognitive function required for a subject to participate in awareness intervention. Furthermore, the occupational tasks used in the intervention should be determined using standardised evaluations added to interviews.

Conclusion

The results of this study indicate the effectiveness of occupational therapy focused on awareness, the subject anticipate his or her mistakes and strategies with the therapist' assistant prior to performing a task and review performance after the task is completed. It would be effective that the therapist assists them to reinforce appropriate strategies prior to undertaking tasks. Furthermore, when assessing awareness, it would be more effective to use a method that directly assesses subjects' statements and qualitative analysis rather than using only a questionnaire based on the scale.

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Conflict of interest

None declared.

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■ORIGINAL ARTICLE

The Impact of NEURO-15 on Performance Skills and Related Factors in Activities of Daily Living in Patients in the Chronic Phase of Stroke

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Abstract: NEURO-15 is a 15-day program that combines low-frequency repetitive transcranial magnetic stimulation (rTMS) and intensive occupational therapy for patients with chronic hemiparesis following stroke. Though the evaluation of upper-limb function has been used in the past to verify the effects of NEURO-15, the reacquisition of performance skills required for daily living has not been sufficiently evaluated.

Therefore, we conducted this study with an objective of clarifying the effectiveness of NEURO-15 from the viewpoint of regaining performance skills in daily living. We conducted the Assessment of Motor and Process Skills (AMPS) and evaluated upper-limb function before and after NEURO-15 to evaluate performance skills in activities of daily living (ADL) in 20 patients with chronic hemiparesis after stroke.

Our results found that not only upper-limb function performance, but also ADL performance skills changed significantly. Significant difference was found in the Wolf Motor Function Test (WMFT) log performance time, the Simple Test for Evaluating Hand Function (STEF), and paralysis of the dominant hand between those who improved and not improved on the AMPS. In particular, the results of this study on dominant hands would be a key findings for applying NEURO-15.

This study showed the effectiveness of NEURO-15 in patients with chronic hemiparesis after stroke from the viewpoint of regaining performance skills.

Keywords: NEURO-15; AMPS; cerebrovascular disease

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Introduction

Over 85% of stroke patients develop hemiplegia, 55−75% of who are left with upper-limb dysfunction [1]. Since upper-limb function is closely related to functions of daily living, patients strongly desire improvement in such functions, and approaches to improve upper-limb functions in hemiplegic patients are actively being studied.

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In recent years, many interventions have been attempted based on research involving the plasticity of the brain and functional restructuring of cranial nerves, such as robot-assisted training [2], constraint-induced movement therapy [3], repetitive transcranial magnetic stimulation (rTMS), transcranial direct current stimulation [4]. Among these approaches, rTMS has especially garnered attention due to its low invasiveness to subjects. rTMS stimulates cerebral cortical neurons noninvasively and without pain, high-frequency rTMS enhances local nerve activity at the stimulated site and low-frequency rTMS works to inhibit local nerve activity at the stimulated site [5]. Using low-frequency rTMS, the unaffected side of the cerebrum is stimulated. By weakening the interhemispheric interactions from the unaffected side to the affected side of the cerebrum, functional compensa-

tion by the affected side of the cerebrum is promoted. In recent studies, the application of rTMS in the treatment of upper-limb function in patients with upper-limb paralysis following the chronic stage of stroke has been reported [6, 7]. Fregni et al. performed continuous stimulation using rTMS for five days, and found it to be safe and effective in improving upper-limb function [7]. A meta-analysis of rTMS treatment for stroke patients reported when comparing the low-frequency and the high-frequency rTMS in the subgroup analysis, the effect size was 0.69 and 0.41, respectively, which means that low-frequency rTMS is superior [8].

Kakuda et al. developed NEURO-15 as a rehabilitation intervention that uses low-frequency rTMS for patients in the chronic phase of stroke [9, 10]. NEURO-15 is a 15-day intervention program that combines low-frequency rTMS and intensive occupational therapy. After increasing the plasticity of the cerebrum with low-frequency rTMS, an occupational therapist uses a one-on-one approach of intensive frequency to improve the use of the upper limbs in daily living through intensive occupational therapy. High effectiveness of NEURO-15 in patients in the chronic phase of stroke has been reported in a randomized comparative study that used constraint-induced movement therapy as the control group [11]. Kakuda et al. [12] reported on the safety and improved upper-limb function in a comparative study of over 1,700 stroke patients in the chronic phase of stroke.

However, there are some issues with NEURO-15 that have not been sufficiently examined. Though the effects of NEURO-15 on upper limb function have been verified in the past, there has not been sufficient evaluation of the reacquisition of performance skills in daily living.

The objective of this study was to show the effectiveness of NEURO-15 for patients with chronic hemiparesis after stroke from the viewpoint of not only upper-limb functions but also regaining performance skills in daily living. We examined if the significant difference was found in upper limb function evaluation with NEURO-15 and subject characteristics between those who improved and not improved on the AMPS.

Methods

Schedule (Fig. 1)

Evaluation was performed on the day of admission, and treatment sessions began the following day. NEURO-15 consisted of two sessions per day, one in the morning and one in the afternoon. Patients were given Sundays off, so 15 days of hospitalization resulted

<table>
<tr><td></td><td>Tuesday</td><td colspan="2">Wednesday–Saturday</td><td>Sunday</td><td colspan="2">Monday–Saturday</td><td>Sunday</td><td colspan="2">Monday</td><td>Tuesday</td></tr>
<tr><td rowspan="3">Morning</td><td rowspan="3">Admission</td><td colspan="2">Low–frequency rTMS (20min)</td><td rowspan="6">No treatment</td><td colspan="2">Low–frequency rTMS (20min)</td><td rowspan="6">No treatment</td><td colspan="2">Low–frequency rTMS (20min)</td><td rowspan="3">Discarge</td></tr>
<tr><td rowspan="2">Intensive OT</td><td>One–to–One (60min)</td><td rowspan="2">Intensive OT</td><td>One–to–One (60min)</td><td rowspan="2">Intensive OT</td><td>One–to–One (60min)</td></tr>
<tr><td>Self exercise (60min)</td><td>Self exercise (60min)</td><td>Self exercise (60min)</td></tr>
<tr><td rowspan="3">Afternoon</td><td rowspan="3">Pre–treatment evaluation</td><td colspan="2">Low–frequency rTMS (20min)</td><td colspan="2">Low–frequency rTMS (20min)</td><td colspan="2" rowspan="3">Post–treatment evaluation</td><td rowspan="3"></td></tr>
<tr><td rowspan="2">Intensive OT</td><td>One–to–One (60min)</td><td rowspan="2">Intensive OT</td><td>One–to–One (60min)</td></tr>
<tr><td>Self exercise (60min)</td><td>Self exercise (60min)</td></tr>
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Fig. 1. The schedule of 15-day combination protocol of low-frequency rTMS and intensive OT.
Two sessions of 20-min rTMS and 120-min Intensive OT are provided daily, except for Sundays and the days of admission/discharge.

in 21 treatment sessions. Patients were re-evaluated the day prior to discharge. Evaluations at admission and at discharge were performed in the same order.

Subjects

In this study, we used the inclusion criteria for NEURO-15 established by Kakuda et al. [9] (Table 1). The study population consisted of 20 patients who were hospitalized for NEURO-15 in our hospital for the research period (2016.09.01−2017.08.31) approved by the ethics committee of Nishi-Hiroshima Rehabilitation Hospital. Table 2 shows the pre-treatment demographic information. Nine males and 11 females were included in the study, and had a mean age of 64.85 ± 8.52 years. The mean time from stroke onset to study enrollment was 37.95 ± 29.76 months. There were 11 individuals with right hemiplegia and nine with left hemiplegia in the study population. The Brunnstrom Recovery Stage (BRS) score for the upper limbs was III for two, IV for eight, V for six, and VI for four subjects. The BRS score for the fingers was III for four, IV for nine, and V for seven subjects. All subjects lived in the area, were not hospitalized or in a facility, and were independent in terms of personal activities of daily living (PADL) in their own homes.

Informed consent for the study and treatment was obtained from all patients. The ethics committee of Nishi-Hiroshima Rehabilitation Hospital approved the implementation of this study.

Table 1. Inclusion Criteria for NEURO-15

1	More than 12 months since stroke onset.
2	Brunnstrom stage 3−5 for hand–fingers of the affected upper limb (ability, at least subjectively, to flex the fingers with/without extension).
3	Attainment of a plateau state of motor functional recovery at study entry. Confirmation of the plateau state of recovery established by an experienced physician and occupational therapist.
4	History of a single stroke only (no bilateral cerebrovascular lesions).
5	No history of seizure. No documented epileptic discharge on the pretreatment electroencephalogram.
6	No cognitive impairment (i.e., pretreatment Mini Mental State Examination Score of 26).
7	High level of motivation toward rehabilitation.
8	Sufficiently understands the theory and content of NEURO-15, and consents to its implementation.
9	Independent ADL at home.
10	No pathological conditions referred to as contraindications for rTMS in the guidelines suggested by Wasserman (e.g. cardiac pacemakers, intracranial implants, implanted medication pumps, epilepsy, pregnancy)[13].

Table 2. Demographic data of the study population

		M ± SD/N (%)
Age at admission (years)		64.85 ± 8.52
Gender	Male	9 (45)
	Female	11 (55)
Diagnosis	Cerebral infarction	8 (40)
	Intracerebral hemorrhage	12 (60)
Affected side	Right	11 (55)
	Left	9 (45)
Brunnstrom stage		
upper limb	III	2 (10)
	IV	8 (40)
	V	6 (30)
	VI	4 (20)
hand–fingers	III	4 (20)
	IV	9 (45)
	V	7 (35)
Handedness	Right	18 (90)
	Left	2 (10)
Hemiparesis of dominant upper limb		11 (55)
Time since stroke onset (months)		37.95 ± 29.76

Values are numbers (%) or mean ± standard deviation.

Procedure

Low-frequency rTMS

For low-frequency rTMS, we used a coil in the shape of a figure eight with a diameter of 70 mm and a Mag Pro R30 Mag Venture stimulator (Farum, Denmark). For each rTMS session, 1 Hz low-frequency rTMS was applied to the motor cortex of the unaffected side of the cerebrum for 20 minutes (1,200 stimulations total). The area stimulated by the low-frequency rTMS corresponded to the fingers in the motor cortex of the unaffected side of the cerebrum; in other words, the area in which the motor evoked potential (MEP) of the first dorsal interosseous muscle in the unaffected upper limb was induced at its maximum on the electromyogram (EMG) (Fig. 2). The intensity of stimulation was set at 90% of the motor threshold (the minimum intensity of stimulation able to induce MEP in the stimulation site). Subjects were seated in reclining wheelchairs, and their heads were fixed during stimulation.

Intensive occupational therapy

Intensive occupational therapy consisted of one 60-minute individual occupational therapy session and one 60-minute voluntary training session. The objective of the intensive occupational therapy was to improve the function of the paralyzed upper limb and reacquire the performance skills required for activities of daily living (ADL). The training was determined by an occupational therapist upon obtaining relevant information from physicians, nurses, and medical social workers, and consid-

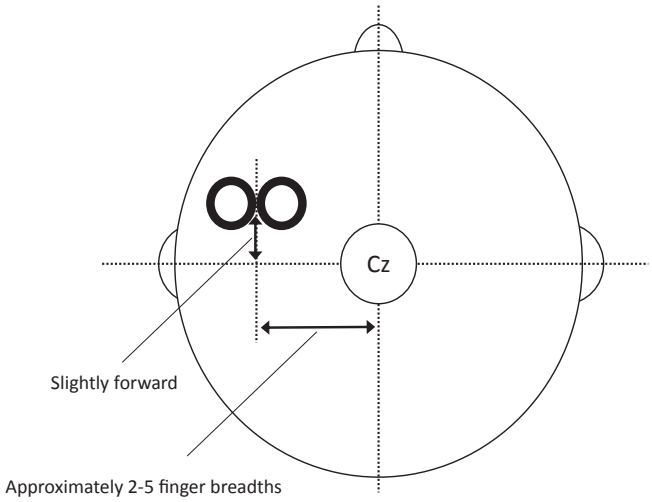

Fig. 2. Stimulation site for low frequency rTMS.
Stimulate the motor center for the hand and finger which is located about 2−5 finger breadths away from Cz (vertex) based on the international 10−20 method, and slightly forward.

ering the needs, living condition, and degree of disorder of the subjects. Training differed slightly depending on the skills and conditions of the subjects. However, the purpose of the training was common, and the duration of training was the same for all subjects.

In actual individual occupational therapy, an occupational therapist with at least five years of experience working with cerebrovascular disease patients worked with patients one-on-one, while a team of occupational therapists worked with each patient. The occupational therapists discussed the development of each program. Specific training was based on the evaluation of skeletal alignment and muscle tone of the upper limbs and torso for each subject, and aimed to improve support for the upper limbs and extend the functional range of motion in joints. For the upper extremities, group flexion and extension exercises and movements that separated the fingers were used depending on the characteristics of the subject. As the upper limb function of subjects changed, training was focused on upper limb use in actual daily living.

After individual occupational therapy, subjects performed voluntary training for 60 minutes in an individual booth within the occupational therapy room. The occupational therapist and subjects discussed the creation of the individual occupational therapy plan. Specifically, training began with stretching as warm up, followed by actual training using daily items related to ADL and APDL.

Assessment Tools

Upper limb evaluation

Evaluation of the upper limbs included upper limb items of the Fugl-Meyer Assessment (FMA), the Wolf Motor Function Test (WMFT), the Simple Test for Evaluating Hand Function (STEF), and the Modified Ashworth Scale (MAS) for elbow flexors, wrist flexors, and finger flexors, and was implemented by the occupational therapist in charge.

The FMA is a comprehensive evaluation battery for motor function that can comprehensively evaluate upper and lower limb dysfunction from voluntary movement, balance, sensation, and range of motion. The reliability and validity of the FMA have been confirmed [14]. In this study, we implemented 33 items from upper limb items: A (shoulder, elbow, and forearm, with a maximum score of 36); B (wrist, with a maximum score of 10); C (hand, with a maximum score of 14); and D (cooperation and speed, with a maximum score of 6). As each item was rated on a three-point ordinal scale (0 = cannot perform, 1 = can perform partially, 2 = can perform fully), the maximum motor performance score for the upper limbs was 66 points.

The WMFT is an objective evaluation created to evaluate functions of the paralyzed upper limb before and after CIMT. The reliability and validity of the WMFT has been confirmed [15]. It consists of 15 items: 6 motor items and 9 object operation items. The time taken for each task was measured and the total time used as the score. However, since the total time score needed to perform the 15 tasks has bias, in this study, similar to Wolf et al. [16], we used the natural logarithm of the time taken to perform tasks. The quality of such movements can be evaluated on a six-point scale, such as the Functional Ability Scale (FAS), which ranges from 0 (no attempt) to 5 (normal movement).

The STEF measures the time taken to move or operate 10 different types of objects, and evaluates using a ten-point scale to calculate the total score. It is widely used as a highly reliable test for patients who are in the process of recovering upper limb function [17]. The scores range from 10−100.

The MAS is a semi-quantitative scale that evaluates the degree of spasticity. Bohannon improved the scale developed by Ashworth as a six-step evaluation method by adding “grade +1”, and many have reported its high reliability [18]. In this study, we measured elbow flexors, wrist flexors, and finger flexors and converted “1+” in MAS to 1.5 according to the method of Kaji et al. [19]. Higher scores indicate higher muscle tone.

Evaluation of performance skills in ADL

In this study, to evaluate performance skills in daily living, we used the assessment of motor and process skills (AMPS) [20], which evaluates performance skills in PADL and instrumental activities of daily living (IADL). The AMPS has been standardized using multi-faceted Rasch analysis, and there are no significant differences in mean ADL ability measure (logits) in AMPS between persons with right or left hemispheric stroke, despite hemisphere-specific differences in underlying cognitive and physical impairments [21].

The AMPS has 125 daily living tasks that are standardized at different difficulties, and subjects choose and perform at least two tasks they feel are familiar from their daily living. The evaluator evaluates 16 motor skill items and 20 process skill items on a four-point scale through observation. Motor skill items are a group of skill items that indicate the action of moving themselves or objects when interacting with objects and the environment during tasks. Process skill items are a group of skill items that indicate the actions of choosing and using tools and materials, logically advancing actions and tasks, and correcting actions when there is a problem. Results of the AMPS are indicated in the ADL motor scale and the ADL process scale. These measures reflect the relative impact of motor and process skill deficits on IADL performance [20, 21]. The cut-off value of effectiveness for the ADL motor scale was 2.0 logit, and 1.0 logit for the ADL process scale. A change of 0.3 logit indicates that there was a clinical and observational change. A change of 0.5 logit indicates that there was a statistically significant change [21]. Evaluation of the AMPS was performed by an occupational therapist certified in AMPS evaluation and not involved with the implementation of Neuro-15 at our hospital.

Analysis

To confirm the effectiveness of NEURO-15, we used the Wilcoxon signed-rank test and examined changes in performance skills in ADL and upper limb function before and after NEURO-15.

To confirm what subject characteristics were involved with changes in performance skills in ADL, we assigned subjects who had a change in the ADL motor scale of 0.3 logit or more (clinical and observational change) into the changed group, and those who did not show such changes into the unchanged group.

We then examined if the significant difference was found in changes in upper limb evaluation and subject characteristics (age, gender, time from stroke onset, BRS, and paralysis in the dominant hand) between those who improved and not improved on the AMPS using the Mann-Whitney U test, Fisher's exact probability test, or Student's t-test.

For changes in upper limb evaluation, we subtracted the values before and after the implementation so that positive numbers indicated improvement (for the WMFT log performance time, the amount of change = value after implementation – value before implementation). All statistical analyses were performed using SPSS version 19.0 (SPSS Inc., Chicago, IL).

Results

Changes before and after implementation of NEURO-15 (Table 3)

The ADL motor scale of the AMPS increased significantly ($p < 0.001$). Figure 3 shows individual changes. The ADL motor scale index of the AMPS indicated that two subjects were within the range of questionable to mild clumsiness and/or increased physical effort (1.7−1.9 logit) and 18 subjects were within the range of mild to moderate clumsiness and/or increased physical effort or fatigue (0.5−1.6 logit) before implementation of NEURO-15. After NEURO-15, six subjects were within the range of questionable to mild clumsiness and/or increased physical effort (1.7−1.9 logit) and 14 subjects were within the range of mild to moderate clumsiness and/or increased physical effort or fatigue (0.5−1.6 logit).

The ADL process scale of the AMPS increased significantly ($p = 0.011$). Data are presented in Fig. 3. Before the implementation of NEURO-15, two subjects were within the range of efficient (1.3−2.1 logit), 16 subjects were within the range of questionable inefficiency/disorganization (1.0–1.2 logit), and two subjects were within the range of questionable to mild inefficiency/disorganization (0.7−0.9 logit). After NEURO-15 implementation, two subjects were within the range of efficient (1.3−2.1 logit), 17 subjects were within the range of questionable inefficiency/disorganization (1.0−1.2 logit), and one was within the range of questionable to mild inefficiency/disorganization (0.7−0.9 logit).

The total score of the FMA increased significantly ($p < 0.001$) and the category A, B, C, and D scores changed significantly ($p = 0.003$, $p = 0.034$, $p = 0.004$, and $p = 0.046$, respectively).

The WMFT log performance time decreased significantly ($p = 0.001$) and the FAS score increased significantly ($p = 0.001$). The total STEF score also increased significantly ($p = 0.04$). The elbow joint, wrist, and fingers in the MAS score showed a significant decrease in muscle tone ($p = 0.008$, $p = 0.015$, $p = 0.001$, respectively).

Table 3. Changes in evaluation items before and after Neuro-15

	At admission	At discharge	*P*-value*
Evaluation of performance skills in daily living			
AMPS			
ADL motor scale	1.16 ± 0.37	1.40 ± 0.34	< 0.001*
ADL process scale	1.09 ± 0.13	1.14 ± 0.11	0.011*
Upper limb function evaluation score			
The FMA			
The total score	43.90 ± 12.55	46.35 ± 12.21	< 0.001*
category A	26.65 ± 5.76	27.70 ± 5.23	0.003*
category B	5.10 ± 3.73	5.40 ± 3.73	0.034*
category C	9.55 ± 3.79	10.40 ± 3.44	0.004*
category D	2.65 ± 1.81	2.85 ± 1.81	0.046*
The WMFT log performance time	2.98 ± 1.41	2.74 ± 1.47	0.001*
The FAS score	42.00 ± 14.80	43.85 ± 14.49	0.001*
The total STEF score	20.30 ± 31.98	22.75 ± 33.71	0.041*
The MAS score			
elbow flexors	1.15 ± 0.76	0.88 ± 0.65	0.008*
wrist flexors	1.13 ± 0.74	0.88 ± 0.67	0.015*
finger flexors	1.18 ± 0.85	0.85 ± 0.69	0.001*

Values are number or mean±standard deviation.
AMPS, Assessment of Motor and Process Skills; FMA, Fugl-Meyer Assessment; WMFT, Wolf Motor Function test; FAS, Functional Ability Score; STEF, The Simple Test for Evaluating Hand Function; MAS, Modified Ashworth Scale.
By Wilcoxon signed-rank test.
*P values < 0.05 were considered statistically significant.

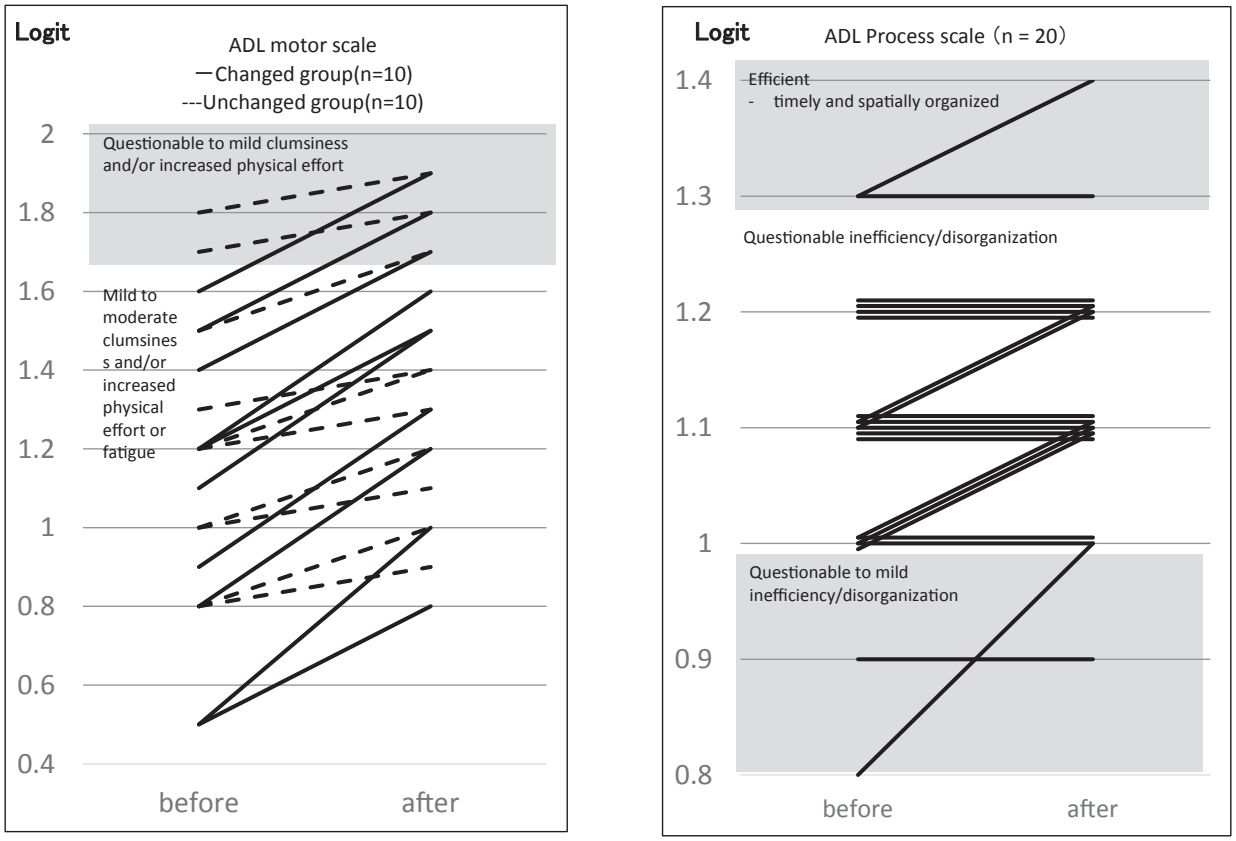

Fig. 3. Changes in ADL Motor/Process Scale.

Comparison of changes in upper limb evaluation and subject characteristics between the changed group and the unchanged group (Table 4)

The changed group in the AMPS scores tended to be those with paralysis of the dominant hand compared with the unchanged group, and whether the dominant hand was paralyzed was significantly involved with the changes in performance skills ($p = 0.035$). In the upper limb evaluation, there was no significant difference between the two groups before the implementation of NEURO-15; however, after NEURO-15 the changed group had shorter WMFT log performance times compared to the unchanged group, while the total STEF scores increased. Results of these two upper-limb function evaluations were significantly involved with changes in performance skills ($p = 0.006$ and $p = 0.039$, respectively).

Discussion

Effects of NEURO-15 on upper limb function and performance skills in daily living

For upper limb evaluation, A, B, C, D, the total FMA score, the time taken to perform tasks in the WMFT, FAS, and the STEF, and the MAS score showed significant changes before and after the implementation of NEURO-15, showing improvement in upper limb function as a result of NEURO-15. These results are similar to those found in previous studies [9, 10].

There was significant improvement in the ADL motor scale in the AMPS after the implementation of NEURO-15, and ten of 20 subjects showed a 0.3 logit or higher change indicative of an observational change. NEURO-15 aims to improve the use of upper limbs in daily living through intensive occupational therapy after increasing the plasticity of the cerebrum through low-frequency rTMS; therefore, in the AMPS, the scores of the skill items for the patients' movements of themselves or objects when interacting with objects and the environment during performing tasks are reflected [21]. Thus, our results confirm that there were changes in the ADL motor scale. The reason that improvement was observed in the performance skills in addition to the upper limb function was because the intervention approach that values the use of upper limbs in actual daily living in response to changes in upper limb function of subjects through intensive occupational therapy was effective.

On the other hand, though there was significant improvement in the process skill items after NEURO-15, none of the subjects met the 0.3 logit change that indicates both a clinical and an observational change. Process skill items are sensitive to whether subjects can live independently at home [21]. Subjects in this study lived in the area, were not hospitalized or in a facility, and received NEURO-15 of their own volition; thus, they were able to choose the required two-week hospitalization on their own. In actuality, the mean ADL process scale of subjects before NEURO-15 was 1.09 logit, which was above the cut-off value of effectiveness (1.0 logit) [21]. Therefore, the high skill level present prior to NEURO-15 and the ceiling effect both impacted the poor change in the scores.

As such, NEURO-15 not only improved upper limb function for patients with chronic hemiparesis after stroke, but also had effects on the reacquisition of performance skills in daily living.

Significant difference in the change in upper limb function evaluation and subject characteristics between the changed group and the unchanged group

Our results showed that changes in the WMFT log performance time and the total STEF score were significantly larger in the changed group compared with the unchanged group, and were involved in upper limb function evaluation. The characteristics of upper-limb function evaluation used in this study were as follows: FMA calculates the total score by comprehensively evaluating upper limb function, while MAS is an evaluation specialized for muscle tone. The WMFT and STEF are characterized by calculating the score by measuring the time to perform specific tasks, including elements such as pinching and operating using actual objects, as well as reaching into various spaces [14, 16]. On the other hand, the ADL motor scale of the AMPS scores the quality of performance, such as physical effort and awkwardness, through the observation of specific tasks; thus, the time taken to perform these tasks are reflected in the scores. In other words, the reason that only the WMFT log performance time and the STEF showed significant differences between the two groups was because the evaluation method measured the time taken to perform specific tasks. Therefore, to improve performance skills in ADL in future interventions, actual objects should be used in intensive occupational therapy, and the speed of performance should be taken into consideration.

Compared with the unchanged group, the changed group had significantly more subjects with a paralyzed dominant hand. Subjects without paralysis in the non-dominant hand, who were common in the unchanged group, probably used their dominant hand to perform tasks in daily living, and were already capable of performance skills in daily living. Therefore, compared to subjects whose dominant hand was paralyzed, the impact of improved upper limb function by NEURO-15 was difficult to observe in the ADL motor scale of the AMPS.

Table 4. Comparison of changes in upper limb evaluation and subject characteristics between the changed group and the unchanged group

		The changed group (n = 10)	The unchanged group (n = 10)	*P*-value*
Demographic data				
Gender	Males	5	4	0.5
	Females	5	6	
Handedness	Right	9	9	0.763
	Left	1	1	
Affected side	Right	7	4	0.185
	Left	3	6	
Side of upper limb hemiparesis	Dominant hand	8	3	0.035*
	Non dominant hand	2	7	
Brunnstrom Stage (at admission)				
Upper limb	III	1	1	0.300
	IV	2	6	
	V	4	2	
	VI	3	1	
Hand-fingers	III	2	2	0.931
	IV	4	5	
	V	2	2	
	VI	2	1	
Age at admission(years)		65.80 ± 7.89	63.90 ± 9.43	0.879
Time since stroke onset (months)		28.60 ± 23.98	47.30 ± 33.19	0.130
Upper limb function evaluation score before Neuro-15				
The FMA				
The total score		44.90 ± 14.18	42.90 ± 11.36	0.762
category A		26.90 ± 6.47	26.40 ± 5.30	0.820
category B		5.40 ± 3.72	4.80 ± 3.91	0.732
category C		9.70 ± 4.06	9.40 ± 3.72	0.760
category D		3.00 ± 1.76	2.30 ± 0.189	0.415
The WMFT log performance time		2.74 ± 1.45	3.22 ± 1.41	0.545
The FAS score		45.00 ± 15.08	39 ± 14.67	0.430
The total STEF score		23.60 ± 31.44	17.00 ± 33.86	0.302
The MAS score				
elbow flexors		1.05 ± 0.80	1.25 ± 0.75	0.558
wrist flexors		1.15 ± 0.85	1.10 ± 0.66	0.638
finger flexors		1.15 ± 0.88	1.20 ± 0.86	0.968
JASID				
amount of use		37.49 ± 15.66	47.11 ± 31.76	0.791
quality of movement		39.08 ± 19.46	39.66 ± 22.47	0.880
Changes in upper limb function evaluation score before and after Neuro-15				
The FMA				
The total score		3.10 ± 2.81	1.80 ± 1.62	0.374
category A		1.40 ± 1.51	0.70 ± 0.95	0.259
category B		0.40 ± 0.52	0.20 ± 0.63	0.194
category C		1.00 ± 1.33	0.70 ± 0.82	0.775
category D		0.20 ± 0.42	0.20 ± 0.42	1.000
The WMFT log performance time		0.37 ± 0.27	0.09 ± 0.21	0.006*
The FAS score		2.60 ± 2.88	1.10 ± 1.73	0.131
The total STEF score		5.10 ± 4.98	−0.20 ± 3.36	0.039*
The MAS score				
elbow flexors		0.25 ± 0.49	0.30 ± 0.35	0.461
wrist flexors		0.25 ± 0.42	0.25 ± 0.35	0.823
finger flexors		0.20 ± 0.26	0.45 ± 0.44	0.147

Values are number or mean ± standard deviation.
FMA, Fugl-Meyer Assessment; WMFT, Wolf Motor Function test; FAS, Functional Ability Score; STEF, The Simple Test for Evaluating Hand Function; MAS, Modified Ashworth Scale.
By the Student's *t*-test or Fisher's exact probability test or Mann–Whitney U test.
**P* values < 0.05 were considered statistically significant.

There is a possibility that subjects whose non-dominant hand was paralyzed need further strategies by which to transfer improved upper limb function to skills in daily living.

Limitations

The limitations of this study were the lack of a control group, since subjects were all voluntarily hospitalized for NEURO-15, the variation of the characteristics of subjects and the mixture of stroke patients with different levels of motor abilities and side of heimplegia.

The effect of NEURO-15 in terms of upper limb improvement was high in subjects whose BRS was four. Since there were a small number of subjects in this study, we were unable to make comparisons based on BRS. In the future, the number of subjects should be increased in order to examine if the contribution of NEURO-15 in the reacquisition of performance skills in daily living changes depending on the degree of paralysis.

Conclusions

We were able to show the effectiveness of NEURO-15 for patients with chronic hemiparesis after stroke, not only for the improvement of upper limb function but also for the reacquisition of performance skills in daily living. We also showed that the significant difference was found in improved task performance speed and paralysis of the dominant hand between those who improved and not improved on the performance skills in ADL after NEURO-15.

Declaration of interests

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the present paper.

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■ORIGINAL ARTICLE

Development of a Method that Uses Reaction Time to Evaluate Attention Deficit Associated with Changes in Dynamic Visual Stimuli

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Abstract: Attentional functions are essential to safely and smoothly perform activities of daily living. A range of different symptoms is observed in patients with impairments of attentional functions. Thus, the same patient may show differences in symptoms depending on the environment in which he or she is situated. In this study, we sought a means to characterize attention deficit with higher sensitivity than conventional neuropsychological tests, such as the Trail Making Test (TMT) and the Clinical Assessment for Attention (CAT), do. We developed two reaction time (RT) tasks: a simple task and a speed change task. We then enrolled 10 right-handed healthy older adults with no history of brain injury and 10 right-handed patients with stroke to perform the RT tasks. In addition, the stroke group underwent the TMT, the CAT and behavioral observation by an occupational therapist to identify symptoms characteristic of attention deficits. Results for findings of attention deficits on standard neuropsychological tests had a sensitivity of 25% in static situations (e.g., desk activities) and 33% in dynamic situations (e.g., walking or moving). In contrast, when applied to static situations, the simple and speed change RT tasks achieved a sensitivity of 75% and 100%, respectively. The sensitivity in dynamic situations was 33% to 44% for the simple task and 100% for the speed change task. These results suggest that the RT tasks developed in this study are capable of identifying attentional deficits in patients with stroke, and may be more sensitive than neuropsychological testing combined with behavioral observations.

Keywords: Assessment, Attention, Reaction time methods, Visual search

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Introduction

During the course of our daily activities, we are able to pay general attention to our surroundings to find target objects while avoiding obstacles. At the same time, we are also able to continue performing target activities without being distracted more than necessary by things in our surroundings that are not relevant to the task at hand. These functions are called attentional functions, and they are essential to safely and smoothly perform activities of daily living (ADL) and activities parallel to daily living (APDL). A range of different symptoms is observed in patients with impairments in these attentional functions. Thus, the same patient may show different symptoms depending on the environment in which he or she is placed. Moreover, medical professionals do not fully understand this pathology. The conventional methods for clinical evaluation of attention deficit use written neuropsychological screening tests and combine them with behavioral observations. How-

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ever, it has been reported that some patients who score higher than the standard for impairment on these written tests, nevertheless exhibit attention deficits in real-life situations such as falling while walking, getting into automobile accidents, etc [1]. Therefore, it has become clear that in some patients a difference exists between their results on existing clinical tests and the actual symptoms encountered in daily living.

Towards better diagnosing and understanding attentional deficits, there are prominent examples of scorable behavioral observation evaluation methods, including the Ponsford and Kinsella's Attentional Rating Scale (ARS), developed by Ponsford and Kinsella (1991) [2], and the Moss Attention Rating Scale (MARS), developed by Whyte, Hart, Ellis, and Malec (2003, 2008) [3, 4] being used in combination with written clinical tests of attention. However, evaluation by behavioral observation depends greatly on the experience of the evaluator, and it is difficult to eliminate the possibility that an occupational therapist with little experience might overlook clinical findings of attention deficit. Furthermore, evaluation results for the same patient on the same day may differ depending on the environment in which the patient is observed; thus, the effect of environmental dependence must also be studied.

In the fields of psychology and brain science, attention is classified from the perspective of visual information processing, and efforts to understand its mechanisms are underway. These classifications include stimulus-driven (bottom-up) attention and voluntary (top-down) attention [5]. The sequence in which bottom-up attention is processed is believed to change based on the salience of visual stimuli, and this fact is considered to be extremely important for avoiding danger in situations where the surrounding environment is constantly changing, as it is in real, everyday life [6]. When the characteristics of the existing tests are examined according to this classification of attention, it is clear that the tests include many elements of top-down attention, in which cognitive processing is performed by focusing attention on a visual target such as letters or figures printed on a sheet of paper. A small percentage of the elements in these tests also involve aspects of bottom-up attention, as the salience of changing stimuli is continually processed. We postulate that these characteristics are one reason why the results of the existing tests often do not agree with attention deficit occurring in daily life.

Therefore, we endeavored to develop an attention deficit evaluation method based on reaction time (RT) as a means of understanding the mechanism of attentional function from the standpoint of visual information processing [7]. In our previous research, two types of tasks in which the placement or flashing pattern of displayed visual stimuli were changed were used together with simple, conventional RT tasks. The results of the RT tasks were then compared with the attention deficit findings from daily life and conventional neuropsychological tests. The results showed that the RT tasks reflected a subject's attention deficit findings with higher sensitivity than the conventional neuropsychological tests, but could not detect attention deficit in subjects suspected of having mild disability [7]. This is believed to be because the two RT tasks that were used only utilized changes in the visual stimuli characteristic of brightness and therefore did not completely reflect the previously described bottom-up attention elements. In a study by Viviani and Aymoz (2001) that used reaction time (RT) to assess the difficulty of perceiving changes in the elements of shape, color, and movement, it was discovered that movement changes were difficult to perceive [8].

In light of the study by Viviani and Aymoz (2001) [8] and in an effort to develop an evaluation method capable of appropriately reflecting attention deficit, we developed an RT task in which the speed of displayed visual stimuli changed. We then studied how the results of this task related to attention deficit findings.

Subjects and Methods

Subjects

The subjects were ten right-handed healthy older adults with no history of brain injury (mean age, 71.3 ± 6.1 years; 6 males, 4 females) and ten right-handed patients with stroke (mean age, 70.4 ± 6.4 years; 7 men, 3 women). Both the healthy older adults and the stroke patients were selected only if they had no overt decline in cognitive function, with a Mini-Mental State Examination (MMSE) score of 24 points or higher. Additional exclusion criteria among the stroke patients were: motor function impairment severe enough to interfere either with carrying out the touch sensor operations or performing neurological tests using the arms, hands, and fingers of the unaffected side of their body (at or below the standard value in the Simple Test for Evaluating Hand Function [STEF]); observation of hemispatial neglect; a total score below the standard value on either a conventional test or a behavioral test listed in the Japanese version of the Behavioral Inattention Test; and visual field impairment. A detailed profile of the patients is shown in Table 1.

Task Methods

Procedure. The subjects were asked to perform two types of RT tasks (a simple reaction task and a speed change task). In addition, the stroke patients were asked

Table 1. Characteristics of the patients with stroke

Case	Age	Sex	Diagnosis	Time period from the onset	Brunnstrom stage	FIM	STEF	BIT	Visual field defect
1	68	Male	Cerebral infarction (left side)	153M	IV	126	92	143	None
2	61	Female	Subarachnoid cerebral hemorrhage	130M	III	105	89	141	None
3	74	Male	Cerebral infarction (left side)	103M	III	118	88	141	None
4	80	Male	Cerebral infarction (left side)	132M	IV	123	81	144	None
5	64	Male	Cerebral hemorrhage (right side)	69M	III	120	92	145	None
6	64	Male	Cerebral infarction (right side)	104M	IV	126	90	139	None
7	78	Male	Cerebral hemorrhage (left side)	348M	III	104	86	141	None
8	70	Female	Cerebral infarction (right side)	20M	V	116	94	138	None
9	67	Male	Cerebral infarction (left side)	156M	IV	126	90	144	None
10	78	Female	Cerebral infarction (right side)	132M	VI	126	86	141	None

to perform the TMT and the CAT, which are usually used as neuropsychological tests.

The TMT consists of two types of tests, a part A (TMT-A) and a part B (TMT-B). TMT-A is a task in which numbers randomly placed on a sheet of paper are to be connected in order starting with 1. The TMT-B is a task in which number sequences and letter sequences (*Hiragana*) placed randomly on a sheet of paper are to be connected in alternation. In the TMT, the time (seconds) required to complete the task was measured, and an evaluation was performed using that time.

The visual cancellation task is one of the tests in the CAT, and it involves searching for the target hiragana (a type of syllabary in the Japanese language) from among stimuli of hiragana arranged in 6 rows and 52 columns on an A3-sized sheet of paper. The paper contains 114 targets. As for the results, the percentage of correct responses was calculated by referring to the CAT scoring criteria.

In addition, an occupational therapist with 10 or more years of clinical experience also made behavioral observations of the patients in doing desk activities, walking or moving to identify characteristic symptoms of attention deficit in an occupational therapy setting.

RT tasks. The equipment used consisted of a 27-inch iMac manufactured by Apple, a SMART device and a chin support developed by Ohyanagi and Sengoku (2010), and a mouse-type touch sensor, which was incorporated into the SMART device to register motor responses to stimuli displayed on the screen [9]. The subjects began by touching the touch sensor with the index finger of their right hand or the hand on the unaffected side of their body. When they saw the target stimulus on the screen, they released their index finger from the touch sensor as quickly as possible to respond. As it was confirmed that the RTs can be measured with millisecond accuracy by using the SMART device and the touch sensor, the data collected by conducting the RT tasks are reliable.

In the simple reaction task, a black background screen was displayed at random intervals of time for a period of 3 to 5 sec, and afterward, a target stimulus (red circle with a diameter of 1 degree in visual angle) was displayed in the center of the screen. The amount of time from when the target stimulus was displayed until the subject's finger was released from the touch sensor was recorded. Note that if the subject did not react within 1.5 sec after the target stimulus was displayed, the present trail was discontinued. This trial was run 24 times.

In the speed change task, after a black background screen was displayed, 36 red circles with a diameter of 1 degree in visual angle appeared on the screen (the screen had a width with a visual angle of 45 degrees and a height with a visual angle of 26 degrees). All of the red circles moved at a speed of a visual angle of 10 degrees in a randomly determined direction in the up or down and left or right directions (Fig. 1B). After 1.0 or 1.5 sec, the movement of one of the 36 red circles (the target) slowed by 5 degrees every second. As soon as the subject noticed the target, he or she would respond with the sensor. The time from when movement speed of the single target red circle began to change until the patient responded was recorded (Fig. 1A). However, in order to measure the accuracy of the responses, trial runs in which the movement speed did not change were randomly included, and the subject was instructed not to respond in these cases. If the movement speed changed and the subject did not respond within 3.5 sec, the subject was considered to have overlooked the target, and if the movement speed did not change, the run was finished after 3.5 sec. There were 36 trials in total, 24 in which the movement speed of the target changed, and 12 in which the movement speed did not change. The 36 red circles are arranged one by one in randomly predetermined positions in each area obtained by dividing the display into 36 equal parts (4 × 9). Twenty-four red circles arranged in the central areas were randomly selected once for each as a moving target whose direction

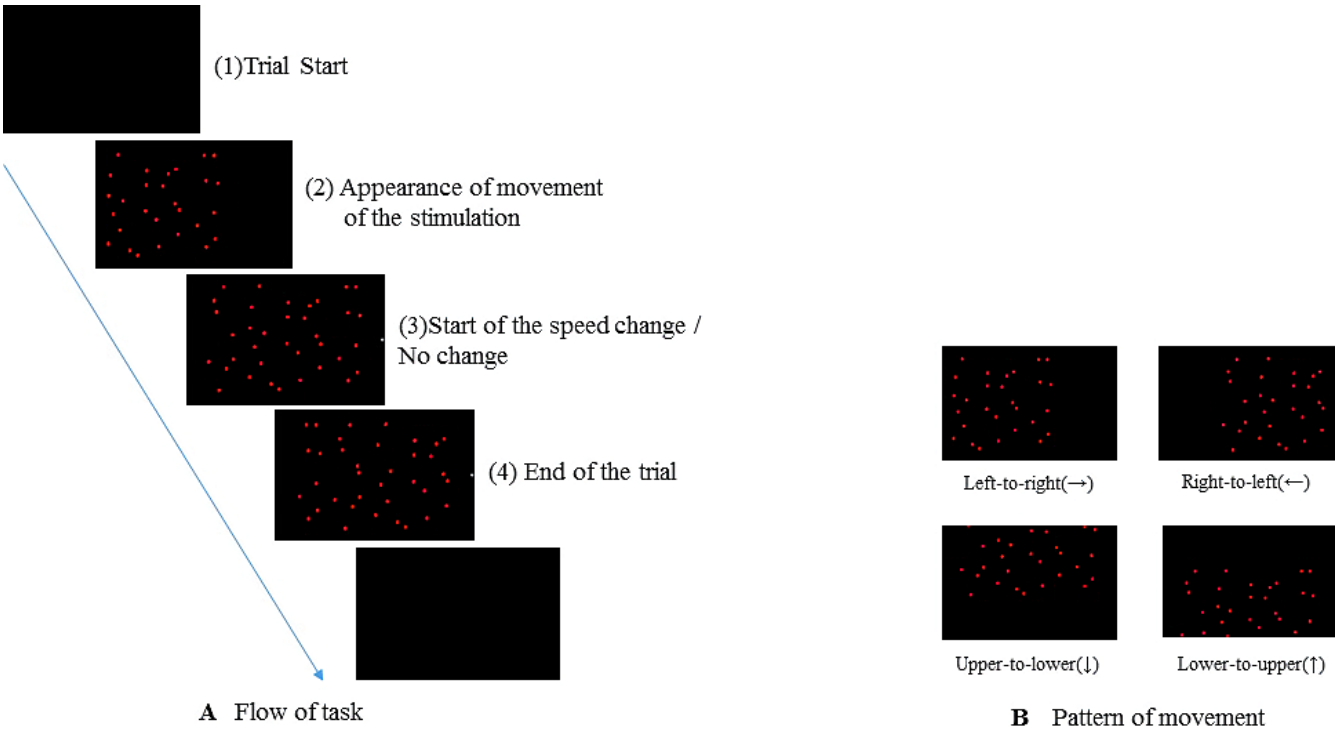

Fig. 1. Speed change RT task.
A. Interval of (1) and (2) is 2.5 sec. Direction of movement (2) is set at random for each trial (the number of occurrences of each direction is the same). Interval of (2) and (3) is 1 sec or 1.5 sec at random (the number of occurrences of each interval is the same). Reaction time is the interval of (3) and (4).
B. There are 4 patterns of 36 red circles moving from left to right, right to left, top to bottom, and bottom to top.

was also determined randomly but the total number of each direction was equally set. Therefore, there was no spatially biased throughout the experiment.

Analytical methods. The mean and standard deviation (SD) of the number of trials that the subject completed successfully without overlooking the target were calculated for each task and used as the results of the RT tasks. In addition, the number of speed change task trials that each subject could not complete were quantified. Then three values, the mean + 1.5 x SD, the mean + 2 x SD, and the mean + 2.5 x SD, were calculated as candidates for standard values reflective of the results of the healthy elderly individuals, and a determination was made as to whether the reaction times of the stroke patients were slower than these standard values. The validity of the three candidates is discussed according to the sensitivity and specificity for attention deficits of the patients.

For the TMT, we referred to the mean value measured in 29 healthy older adults (68 to 94 years old) by Sugimoto, et al. (2014) [10] in which the mean ± SD was 174.0 ± 69.3 sec for TMT-A and 320.8 ± 152.4 sec for TMT-B. The mean +1.5 x SD, the mean + 2 x SD, and the mean + 2.5 x SD were similar to the RT task results; the specific results for TMT-A were 278.0 sec, 312.6 sec, and 347.3 sec, respectively, and the results for TMT-B were 549.4 sec, 625.6 sec, and 701.8 sec, respectively. These values were adopted as standard values of the TMT and were used to judge the existence of attention deficit.

For the visual cancellation task in CAT, standard values for the percentage of correct responses for subjects in their sixties and seventies are 92.9% and 91.7%, respectively. There was no standard set in the CAT for subjects in their eighties, so we used an accuracy rate of 91.7% as the standard value for persons in their seventies and older.

The observational evaluation was a qualitative evaluation of whether findings of attention deficit were shown in static situations, such as during desk activities, or whether attention deficit was shown in dynamic situations, such as when walking or operating a wheel chair.

Because the stroke patients performed the RT task and neuropsychological tests with their dominant hand or the hand on the unaffected side of their body and they had scored values higher than the standard for their age group in the STEF, their upper limb function was judged to have no effect on the results of any of the tasks. Thus,

no corrections for the results of the tasks and the tests were implemented.

All of the results for the RT tasks, the pre-existing neuropsychological tests, the TMT, and the visual cancellation task, were compared with the results from the behavioral observations, and sensitivity and specificity were calculated.

Ethical approval

This study was approved through an ethical review by the Ethics Committee of Sapporo Medical University. In addition, this study was performed in compliance with the Declaration of Helsinki and placed careful attention on protecting the privacy and human rights of the subjects.

When data were measured, the subjects were provided with oral and written explanations of the study purpose, methods, procedures, subjects, anticipated risks, matters related to the human rights of the subjects, the rights of the subjects in the event that they did not provide consent, etc. After this information was provided, the signatures of the individuals who consented to the study were obtained, and only individuals from whom informed consent was obtained were used as subjects in this study. The subjects were also told that they could withdraw consent to participate in the study if they requested such during the study or after the study.

Table 2. Results of the RT task

Subjects	Simple RT		Speed change RT		
	M	SD	M	SD	Omission
Healthy elderly					
1	272.8	42.2	484.6	89.0	0
2	322.1	49.1	498.2	67.4	0
3	252.0	49.2	402.8	59.8	0
4	258.1	34.1	432.3	65.8	0
5	213.8	18.7	501.4	82.0	1
6	198.8	28.5	447.3	128.1	0
7	231.1	31.0	462.4	86.9	0
8	232.2	34.4	539.7	111.8	1
9	240.8	31.1	490.5	90.5	0
10	279.3	39.4	531.7	67.6	0
mean	250.1 ± 33.7		479.1 ± 40.9		
Stroke patients					
1	349.4	75.1	1879.7	708.3	7
2	438.7	34.7	1326.1	729.2	0
3	365.9	128.2	660.1	125.0	0
4	215.5	31.3	802.6	428.3	1
5	226.4	13.6	606.0	256.8	0
6	312.6	85.1	595.5	156.3	3
7	211.5	34.8	1024.7	742.3	1
8	287.0	55.2	843.8	294.1	0
9	281.7	72.6	814.4	328.6	0
10	302.1	50.3	548.4	75.1	0
mean	299.1 ± 68.6		910.1 ± 391.9		

M (msec), Omission (number of incidences).

Results

RT tasks

The results of RT task of the healthy older subjects are shown in Table 2. The overall reaction time for the healthy older subjects was 250.1 ± 33.7 msec in the simple reaction task and 479.1 ± 40.9 msec in the speed change task. There were 2 healthy older subjects who overlooked the target once in the speed change task.

When convenient standard values were calculated from these results, the mean + 1.5 x SD, the mean + 2 x SD, and the mean +2.5 x SD in the simple reaction task were 300.7 msec, 317.4 msec, and 334.4 msec, respectively. The mean + 1.5 x SD, the mean +2 x SD, and the mean +2.5 x SD in the speed change task were 540.5 msec, 560.9 msec, and 581.4 msec, respectively.

The results of RT tasks of the stroke subjects are shown in Table 2. In the simple reaction task, the reaction time was delayed in patients 1, 2, 3, 6, and 10 when the standard value was considered to be the mean + 1.5 x SD. When the standard value was considered to be the mean + 2 x SD or + 2.5 x SD, the reaction time was delayed in patients 1, 2, and 3.

In the speed change task, the reaction time was delayed in all patients when the standard value was considered to be the mean + 1.5 x SD. When the standard value was considered to be the mean + 2 x SD or + 2.5 x SD, the reaction time was delayed in all patients except patient 10. Patients 1 and 6 overlooked the target more often than the healthy older subjects.

Neuropsychological tests

The results of the TMT and the visual cancellation task are shown in Table 3. No matter which standard value was used, none of the subjects showed findings of attention deficit in the TMT. In the visual cancellation task, patients 1, 4, and 9 showed findings of attention deficit.

Behavioral observations

The results of the behavioral evaluation are shown in Table 4. In static situations, such as during desk activities, 3 of 10 patients (patients 1, 2, and 3) showed overt attention deficit findings. Note that patient 8 showed findings suggestive of attention deficit. In addition, in dynamic situations in which visual information changes, such as operating a wheel chair, walking, etc., 9 patients (all patients except patient 10) showed attention deficit findings.

Table 3. Results of neuropsychological tests of patients with stroke

Case	Neuropsychological test		
	TMT-A	TMT-B	Cancellation task
1	187	201	86.8*
2	107	153	97.4
3	92	216	98.2
4	126	194	91.2*
5	87	139	96.5
6	265	347	99.1
7	127	321	95.6
8	184	267	94.7
9	206	372	92.1*
10	170	196	94.7

TMT-A Trail Making Test part A (sec), TMT-B Trail Making Test part B (sec), Cancellation task: Visual cancellation task (rate of cancellation %), *outside of normal range.

Sensitivity and specificity of the neuropsychological tests and RT tasks for the attention deficit findings of the behavioral observation results

In order to verify that the RT tasks developed in this study reflected the attention deficit findings from the behavioral observations better than the existing neuropsychological tests, the sensitivity and specificity of the judgments of attention deficit findings in the RT tasks, TMT, and visual cancellation test were calculated with respect to the attention deficit findings from the behavioral observations of a total of 20 healthy older subjects and stroke patients in static and dynamic situations. The results are shown in Table 5.

In the TMT-A, at all of the standard values, the sensitivity and specificity were 0% and 100%, respectively, for attention deficit findings in static situations, and 0% and 100%, respectively, for attention deficit findings in dynamic situations. In the TMT-B, at all of the standard values, the sensitivity and specificity were also 0% and 100%, respectively, for attention deficit findings in static situations and in dynamic situations. In the visual cancellation test, sensitivity and specificity were 25% and 88%, respectively, in static situations and 33% and 100%, respectively, in dynamic situations.

In static situations in the simple reaction task, sensitivity and specificity were 75% and 81%, respectively, when the standard value was the mean + 1.5 x SD; 75% and 94%, respectively, when the standard value was the mean + 2 x SD; and 75% and 100%, respectively, when the standard value was the mean + 2.5 x SD. In dynamic situations in the simple reaction task, sensitivity and specificity were 44% and 82%, respectively, when the standard value was the mean + 1.5 x SD; 33% and 91%, respectively, when the standard value was the mean + 2 x SD; and 33% and 100%, respectively, when the standard value was the mean + 2.5 x SD.

In static situations in the speed change task, sensitivity and specificity were 100% and 63%, respectively, when the standard value was the mean + 1.5 x SD; 100% and 69%, respectively, when the standard value was the mean + 2 x SD; and 100% and 69%, respectively, when the standard value was the mean + 2.5 x SD. In dynamic situations in the speed change task, sensitivity and specificity were 100% and 91%, respectively, when the standard value was the mean + 1.5 x SD; 100% and 100%, respectively, when the standard value was the mean + 2 x SD; and 100% and 100%, respectively, when the standard value was the mean + 2.5 x SD.

Table 4. Qualitative clinical observations by occupational therapists

Case	Static scene (e.g. activities on the desk)	Dynamic scene (e.g. driving wheel chair, walking)
1	Talkativeness, Distractibility, Restless	Field of view is narrow when moving. Sense of distance is abnormal.
2	Overlook small part caused by lack of confirmation during handwork.	Hit surroundings during wheelchair operation.
3	A little delay in the start of the action.	The sense of distance between the object being small when walking. Action can be modified to be careful.
4	No particular problem	Cannot find a person when walking. Possible to notice defects immediately in the voice over.
5	No particular problem	Rarely, not aware of the objects on the floor.
6	No particular problem	Sense of distance is abnormal during walking. Never hit surroundings.
7	No particular problem	Sometimes hit surroundings.
8	Sometimes mistaken for voice over increases during handwork.	Sense of distance is abnormal. Almost always hit surroundings.
9	No particular problem	Do not try to avoid obstacles even if there is a person or an object, delay in avoiding.
10	No particular problem	No particular problem

Table 5. Sensitivity and specificity for inattention syndrome (the reference value is changed)

Scene	Reference Value	Neuropsychological test			RT tasks	
		TMT-A	TMT-B	Cancellation task	Simple RT	Speed change RT
Static	M + 1.5SD	0/100	0/100	25/88	75/81	100/63
	M + 2.0SD	0/100	0/100		75/94	100/69
	M + 2.5SD	0/100	0/100		75/100	100/69
Dynamic	M + 1.5SD	0/100	0/100	33/100	44/82	100/91
	M + 2.0SD	0/100	0/100		33/91	100/100
	M + 2.5SD	0/100	0/100		33/100	100/100

The value in the table, Sensitivity (%)/Specificity (%).

Discussion

Attention deficit findings of the patients and results of existing neuropsychological tests

The results of the existing neuropsychological tests used in this study showed that the TMT was unable to detect attention deficit findings and that the visual cancellation task was able to detect attention deficit findings. However, the sensitivity was 25% in static situations and 33% in dynamic situations, which are very low values. These results support the previous studies [1] that reported a difference between the results of the neuropsychological tests and symptoms observed in situations such as driving a vehicle or walking. The reason for this is considered to be that the neuropsychological tests involve few changes in visual stimuli and thus are low-salience tasks with narrow display ranges. This suggested that the existing neuropsychological tests alone did not completely reflect the clinical attention deficit findings in either static or dynamic environments.

Attention deficit findings of the patients and the results of RT tasks

In the RT tasks used in this study, the sensitivity toward attention deficit findings in static situations was 75% for simple responses and 100% for the speed change task, both of which were high values. In addition, the sensitivity in dynamic situations was 33% to 44% for simple responses and 100% for the speed change task. The RT tasks used in this study did not contain very many cognitive elements such as letters and numbers, rather they asked subjects to find and respond to targets in an environment where the brightness and speed of visual stimuli changed. Therefore, these tasks were considered to be capable of reflecting attention deficit mainly in dynamic environments, and the sensitivity of the speed change task is considered to support that. We posit that the low sensitivity of the simple reaction task, which is in contrast to the speed change task, may owe to the simple reaction task using only changes in the simple flashing of visual stimuli. This implies that the amount of change of dynamic visual stimuli may have greatly affected the results. Therefore, judging from the sensitivity and specificity of the behavioral observations, a more appropriate evaluation is considered to be one that combines a simple reaction task, in which the change in visual stimuli is relatively small and reflects attention deficit in static situations, with a speed change test, in which the change in visual stimuli is large and reflects attention deficit in dynamic situations.

Standard values

Though there have been a lot of studies aimed at evaluating attention disorders and clarifying their characteristics using RT tasks, no standard value has been clearly determined so far [1, 11]. This is why three candidates for standard values reflective of the results of the healthy older adults are introduced in this study. As a result, the neuropsychological tests in both static and dynamic scenes and the simple reaction task in dynamic scene showed low sensitivity and high specificity for three candidates for standard values, while the simple reaction task in static scene and speed change task in both scenes showed high sensitivity and high specificity for them. From these results, it may be reasonable to set any of the three reference values as the standard value for the RT tasks but more data collection is necessary to conclude it.

Limitation of research and Future outlook

Since the observation scene and activities were limited in this research, only a part of daily life of attention disorder patient could be examined. Previous studies that used RT tasks also contained little information about setting standard values; thus, we think that the establishment of standard values is important in future studies. In addition, the functional structures inside the brain responsible for processing the speed of movement of visual stimuli have recently been discovered [12–14]. If this new information can be exploited to perform

a more functionally segmented clinical evaluation of attention deficit, we believe that more highly individualized occupational therapy could be provided. However, the behavioral observations in our study had many qualitative elements and did not contain a quantitative method. Therefore, they did not allow for such segmentation. In the future, we also hope to study ways in which behavioral observations of attention deficit can be performed in a more quantitative manner. We would also like to enroll a larger number of subjects in order to study the step-wise correlations between RT tasks and various symptoms and the relationship with actual real life activities.

Conflicts of interest statement

The authors have no conflicts of interest relevant to this article.

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