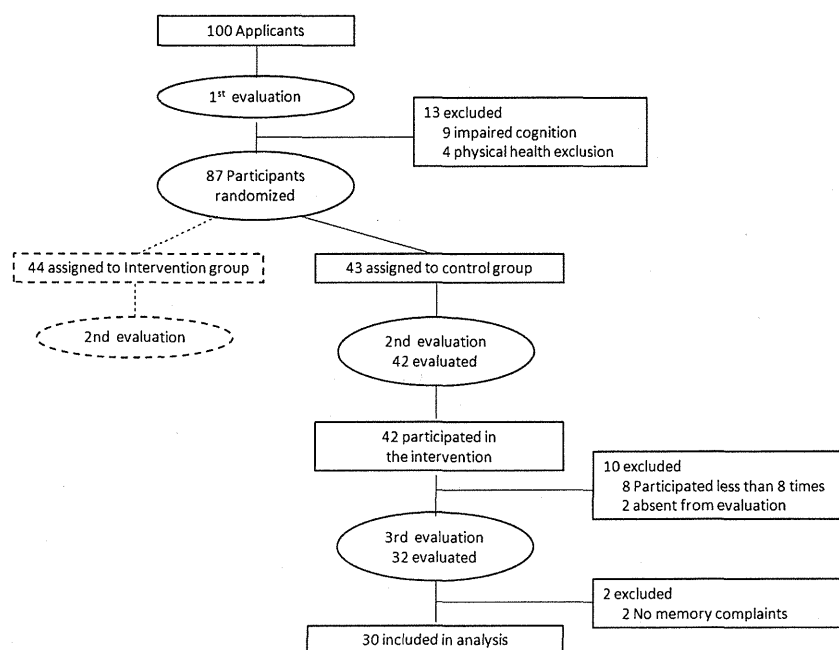


## Intervention for preventing dementia



**Figure 1** Flow of participants through the study.

subjective health status was evaluated with the question “How is your health in general?” using a rating scale from 1 = excellent to 4 = poor. The level of social support was evaluated with the Lubben Social Network Scale Revised (LSNS-R), which gauges social isolation in older adults by measuring the perceived social support received by family, friends and neighbors.<sup>13</sup> Functional capacity was determined using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC).<sup>14</sup> TMIG-IC is a multidimensional 13-item index of competence comprising three dimensions; that is, instrumental self-maintenance, intellectual activity and social role. The index was designed to measure higher level competence in community-dwelling elderly.<sup>14,15</sup> The Satisfaction in Daily Life (SDL), a simple measurement of subjective quality of life (QOL), was used to evaluate the life satisfaction of participants.<sup>16,17</sup> The SDL consisted of 11 items; that is, physical health, mental health, self-care, gait, housework, house facilities, partner and family relationships, hobby and leisure activities, social intercourse, economic state and social security, and having a job. Each item was rated from 1 = dissatisfied to 5 = satisfied. The 15-item short version of the Geriatric Depression Scale (GDS)<sup>18</sup> was used to evaluate depressive symptoms.

### Study design

Evaluation was carried out three times (Fig. 1). After receiving the initial screening and evaluation (first evaluation), 87 eligible participants were randomly divided into two groups of 43 and 44. Participants in the

present study ( $n = 43$ ) were allocated to the control group of another randomized controlled trial (RCT), which is still continuing by adding participants in another district of Maebashi city. The participants in the present study received an educational lecture about nutrition during the control period. After the 12-week control period, 42 participants were evaluated for baseline condition (second evaluation). Effects of the intervention were evaluated at the end of the intervention period (third evaluation). At each evaluation, cognitive and physical function tests and questionnaires were administered to participants. Participants were examined by the questionnaire administered in the first evaluation as to whether they had SMC or not on the following two questions: “Are you concerned about forgetfulness?” and “Have you experienced any memory problems over the past 1 month?”. Participants were considered to have SMC if they answered yes to both of the questions.

Participants were considered as having amnesic mild cognitive impairment (aMCI) by a clinician specializing in dementia according to the following criteria:<sup>19</sup> reported memory complaint; objective memory impairment for age; essentially preserved general cognitive function; largely intact functional activities; and not demented. They were included in SMC in accordance with a previous research on SMC.<sup>20</sup> Participants without SMC were excluded from analysis. However, they participated in the intervention program, because the intervention was carried out as a community service that should be available to all community dwellers.

## Intervention

We administered the 12-week intervention program consisting of pleasant physical activity for 42 participants (Fig. 1). The exercise program includes muscle-stretching exercise in a sitting position (17 items), muscle-strengthening exercise in a sitting position (3 items), muscle-strengthening exercise in a standing position (7 items) and aerobic exercise (3 items). These exercises require comprehensive ability in physical activity consisting of body flexibility, muscle-strength, balance and endurance. The mean duration of the exercise program was 45 min. Participants were encouraged to carry out home exercise based on the exercise program. Walking was recommended to participants as regular exercise. Leisure activities and educational lectures were included in the program in order to motivate participation; for example, cooking, handcraft activity, lectures on physical activities and dental health. Participants received programs once a week in community centers located in the districts where they resided. The program was carried out in two groups of 26 and 16. The program was provided by the following co-medical professional staff: physical therapist, occupational therapist, public health nurse, dietitian and dental hygienist.

Senior citizen volunteers also participated in every program. Maebashi city has promoted participation of the elderly in volunteer activities focusing on long-term care prevention in the community. In the present intervention, 27 senior citizens participated as volunteers. They received training sessions on brain-activating rehabilitation, which emphasized a comfortable atmosphere; empathetic communication with each other; praising each other; having a social role; and errorless learning.<sup>10</sup> They were expected to facilitate communication among the participants and maintain a pleasant atmosphere. In each program, three to seven volunteers participated in assisting the professional staff in carrying out the program.

## Statistical analysis

Statistical analysis was carried out using the Japanese version of SPSS, 17th edition (IBM, Armonk, NY, USA). Analyses were carried out with all the participants, and with those having aMCI and those not having aMCI separately. All results were analyzed by repeated-measures analysis of variance (ANOVA) and Bonferroni's correction post hoc test. We regarded  $P < 0.05$  as showing significance.

## Results

### Flow of participants through the study

Figure 1 shows the flow of participants through the study. In the present study, 42 participants underwent the program after the control period of 3 months. The attendance rate during the intervention was 77.4%. A total of 10 were excluded from the analysis; eight attended the program less than eight times and two were absent from the third evaluation. Two participants were considered to not have SMC based on their answers on the questionnaire. Finally, 30 were included in analysis. Table 1 shows the demographic and clinical characteristics of 30 included participants and those of 12 excluded participants.

### Analysis of all the participants

In the control period (between the first and second evaluation), there was no significant increase in the scores on cognitive and motor tests, except for the "Cued recall task" on the Five-cog test ( $P = 0.001$ ) (Table 2). In the intervention period (between the second and third evaluation), significant improvement was seen on the "Cued recall task" of the Five-cog test ( $P < 0.001$ ) and WDSST ( $P = 0.01$ ) on the cognitive tests (Table 2). There were no significant changes between

**Table 1** Demographic data of the participants

Characteristic	Participants included ( $n = 30$ )	Participants not included ( $n = 12$ )	$P$ -value <sup>‡</sup>
Age <sup>†</sup> (years)	73.7 ± 5.5	75.0 ± 7.7	0.593
Female, $n$ (%)	26 (86.7)	10 (83.3)	0.561
Years of education <sup>†</sup>	11.6 ± 3.8	11.4 ± 2.9	0.881
MMSE score <sup>†</sup>	28.4 ± 1.5	27.3 ± 2.0	0.067
SMC with aMCI, $n$ (%)	7 (23.3)	6 (50.0)	0.095

<sup>†</sup>Results are expressed as: mean ± standard deviation. <sup>‡</sup>Significance was tested using independent Student's  $t$ -tests for continuous variables, and  $\chi^2$ -tests for categorical variables. aMCI, amnesic mild cognitive impairment; MMSE, Mini-Mental State Examination; SMC, subjective memory complaints.

**Table 2** Results of the test scores (all participants,  $n = 30$ )

Scale	Ev. 1 <sup>†</sup> (before Control period)	Ev. 2 <sup>†</sup> (before intervention period)	Ev. 3 <sup>†</sup> (after intervention period)	F-value	P-value	Ev.1 vs 2	Ev.2 vs. 3
Five-cog test							
Character position referencing task	21.3 ± 8.3	21.9 ± 9.1	23.7 ± 8.0	4.171	0.020*	1.000	0.107
Cued recall task	14.1 ± 4.9	17.0 ± 5.5	21.0 ± 6.2	53.189	<0.001***	0.001**	<0.001***
Clock drawing task	6.5 ± 1.4	6.8 ± 0.61	6.9 ± 0.4	3.093	0.084	0.490	0.130
Animal name listing task	15.9 ± 4.7	17.6 ± 5.4	19.0 ± 5.4	8.361	0.001**	0.071	0.173
Analogy task	10.1 ± 2.8	10.8 ± 3.1	10.9 ± 2.9	3.788	0.028*	0.046*	1.000
WDSST	52.7 ± 14.8	56.3 ± 14.2	60.4 ± 15.2	10.050	<0.001***	0.192	0.010*
Subjective health status	2.1 ± 0.5	2.2 ± 0.5	2.1 ± 0.4	0.693	0.504	0.791	1.000
LSNS-R	17.3 ± 5.5	16.4 ± 6.1	17.5 ± 5.6	1.154	0.316	0.975	0.253
TMIG-IC	11.9 ± 1.9	12.1 ± 1.5	12.0 ± 1.7	0.931	0.385	0.249	1.000
SDL	20.9 ± 4.2	20.6 ± 4.1	21.1 ± 4.2	0.254	0.776	1.000	1.000
GDS	3.5 ± 2.9	3.3 ± 2.3	2.7 ± 2.4	2.238	0.116	1.000	0.377
Grip strength	24.9 ± 6.2	26.3 ± 5.7	26.0 ± 6.2	4.212	0.028*	0.072	1.000
One-leg standing duration	34.7 ± 20.0	39.5 ± 21.3	39.8 ± 22.5	2.036	0.140	0.247	1.000
Timed up and go test	5.9 ± 0.8	6.2 ± 1.0	6.1 ± 0.9	3.388	0.041*	0.034*	0.613
5 m maximum walking time	2.7 ± 0.4	2.6 ± 0.4	2.6 ± 0.3	0.081	0.922	1.000	1.000

<sup>†</sup>Results are expressed as: mean ± standard deviation. \* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ . Ev., evaluation; GDS, 15-item short version of the Geriatric Depression Scale; LSNS-R, Lubben Social Network Scale Revised; SDL, The Satisfaction in Daily Life; TMIG-IC, Tokyo Metropolitan Institute of Gerontology Index of Competence; WDSST, Wechsler digit symbol substitution test.

participants on any item on the questionnaire. None of the physical function tests showed significant changes after the intervention.

### *Subanalysis of participants without aMCI and with aMCI*

When seven participants who were considered to have aMCI were excluded, results of subanalyses in 23 participants were similar to those of the analyses in all participants. There were no significant changes shown on analyses of seven participants with aMCI.

## Discussion

The present study investigated the effectiveness of pleasant physical exercise intervention, provided as a service for the prevention of cognitive decline in community-dwelling elderly with SMC. Findings were objectively investigated using cognitive, physical, functional, social and behavioral outcome measures. Through the 12-week intervention, participants with SMC showed improvement in some aspects of cognitive function. In the evaluation carried out after the intervention, significant improvement was seen on the "Cued recall task" of the Five-cog test and on WDSST. Concerning the "Cued recall task", the effects of repeated learning could not be ruled out, as significant improvement was also seen on baseline evaluation.

WDSST is the test of attention and executive function. A previous study suggested that WDSST score is the best cognitive measure to detect unsafe drivers with early dementia of the Alzheimer type and non-demented drivers.<sup>21</sup> Improvement shown on WDSST score suggests that participants have increased abilities to carry out activities of daily living that require attention and executive function.

Although the present study program did not include direct cognitive stimulation, participants showed improvement in cognitive tests scores. The efficacy of intervention carried out in a pleasant atmosphere with an emphasis on interactive communication has been proposed.<sup>10</sup> Throughout the program, the staff and the volunteers were expected to facilitate communication among the participants and maintain a pleasant atmosphere. It is possible that physical activity carried out in the pleasant atmosphere and interactive communication enhanced motivation, which led to improvement of cognitive function.<sup>22</sup>

Preventive programs as municipally-sponsored measures against cognitive decline among community-dwelling elderly have not yet been established. In order to provide appropriate and effective services to prevent cognitive decline, determination of participants and the promotion of effective programs are critical issues. The present study targeted people with SMC. The majority

of elderly participants report SMC,<sup>23,24</sup> and the presence of SMC is considered to be an important first sign or indicator of imminent dementia.<sup>3-5</sup> Participation of elderly subjects with SMC is recommended, because they need such an intervention, and benefits can likely be obtained.

We administered a 12-week intervention of pleasant physical activity program. It has been suggested that physical activity reduces the risk of cognitive decline among demented and non-demented elderly participants.<sup>6,7</sup> Therefore, physical activity should be one of the preferred programs for preventing cognitive decline. Furthermore, physical activity programs have several advantages; it is labor- and time-saving, and cost effective. It might be a competent program to offer as a community service.

Use of volunteers was emphasized in our intervention. It is important to develop human resources who can continuously attend preventive care activities in the community, as the shortage of professional staff has become obvious in an aging society. Participation of volunteers enabled smooth implementation of the program, and alleviated the burden on professional staff. Senior volunteers who joined in the intervention played important roles in facilitating a pleasant atmosphere and smooth communication among participants. Involvement of senior citizen volunteers could be effective for a community-based intervention program for the prevention of cognitive decline.

The present study had several limitations. The number of participants was small; the present study first targeted 42 participants, and 30 participants were finally included in analysis as a result of the 77.4% attendance rate of the intervention. The period of the intervention was relatively short; the intervention was carried out for just 3 months. These factors might limit the ability to generalize the results of the study.

In conclusion, participants with subjective memory complaints who continued the pleasant physical exercise programs for 12 weeks showed improvement in some aspects of cognitive function. Participation of senior citizen volunteers enabled smooth implementation of the program, and alleviated the burden on the professional staff. Thus, the present study showed a community-led intervention for care prevention.

## Acknowledgment

Author contributions: Tadahiko Kamegaya prepared the manuscript mainly, the intervention program described in the present study was provided by a physical therapist, an occupational therapist, public health nurses, a dietitian, and dental hygienists of Long-Term-Care Prevention Team of Maebashi City. Tetsuya Yamagami and Yohko Maki contributed to the preparation of the manuscript. Tomoharu Yamaguchi and

Tatsuhiko Murai contributed to the collection of data. Haruyasu Yamaguchi made the final approval of the manuscript to be published.

The authors thank Rumi Shinohara and Yuko Tsunoda (Gunma University, Maebashi, Japan) for technical assistance. Finally, we express our deep appreciation to all of the participants and senior citizen volunteers of Maebashi city.

## Disclosure statement

This study was supported in part by a Grant-in-Aid for Scientific Research (H22-Ninchisho-Ippan-004) from the Ministry of Health, Labor and Welfare of Japan. Dr Yamaguchi was supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Science, Sports, Culture and Technology, Japan (23300197 and 22650123).

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Original Research Article

# A Randomized Controlled Trial of Brain-Activating Rehabilitation for Elderly Participants with Dementia in Residential Care Homes

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## Key Words

Alzheimer's disease · Brain activity · Dementia care · Non-pharmacological therapies · Randomized clinical trials · Rehabilitation · Reminiscence therapy

## Abstract

**Background/Aims:** We aimed to prove the effectiveness of brain-activating rehabilitation for dementia, which consisted of 5 principles: pleasant atmosphere, communication, praising, social role, and supportive care. **Methods:** The design was a randomized controlled trial that was not blinded. Fifty-four elderly participants with dementia (mean age: 85.2 years) were selected. Intervention based on the 5 principles of brain-activating rehabilitation was conducted for 1 h, twice a week, for 12 weeks (24 sessions). The control group had no treatment. Outcome measures consisted of two observation scales, namely sum of boxes in clinical dementia rating (CDR-SB) and the multidimensional observation scale for elderly subjects (MOSES), and two cognitive tests: the Hasegawa dementia scale revised (HDS-R) and trail making test A. **Results:** Repeated measure ANCOVA showed a significant interaction for total score of CDR-SB ( $F = 7.190, p = 0.015$ ) and MOSES ( $F = 4.525, p = 0.038$ ). There were no significant changes in the two cognitive test scores. **Conclusion:** Intervention based on the principles of brain-activating rehabilitation was effective in maintaining and improving daily life functions in elderly participants with dementia in residential care homes.

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## Introduction

Rehabilitation for dementia, such as reminiscence therapy, reality orientation, cognitive rehabilitation, and physical activity, has an important role in delaying disease progression and functional decline. Studies on rehabilitation for dementia have focused on the differentiation of each technique (e.g. reminiscence therapy, reality orientation) and a comparison of their effects. However, Cochrane reviews on non-pharmacological interventions have highlighted the insufficiency of the available evidence [1–3]. We thought that the principles of intervention are much more important than each technique of intervention because inter-subjectivity between participants and therapists/care staff has a much greater influence than each technique used. When the effects of three kinds of interventions, namely group reminiscence therapy, individual reminiscence therapy, and a group games, were compared in residential care homes, group reminiscence therapy improved memory performance and group games improved well-being, whereas individual reminiscence therapy was less effective. These findings suggested that group membership plays an important role in maintaining and promoting health and well-being [4]. We proposed a new principle of rehabilitation for dementia, brain-activating rehabilitation (BAR) [5], which consists of 5 principles: (1) enjoyable and comfortable activities in an accepting atmosphere; (2) activities associated with empathetic two-way communication between staff and participant, as well as between participants; (3) praising participants to enhance motivation; (4) offering social roles to participants that enhance their remaining abilities, and (5) supportive care to prevent failure, which causes confusion of participants. In fact, BAR was conducted as a combination of several techniques (e.g. reminiscence therapy, reality orientation, games, physical activity, crafts, cooking, and singing) to suit the participants based on these 5 principles. BAR was expected to enhance participants' motivation and maximize the use of their remaining functions and prevent the disuse of functions [5]. BAR was expected to enable participants to recover both a desire for life and their self-respect. Enhanced motivation induced by BAR can lead to amelioration of the behavioral and psychological symptoms of dementia and improvements in activities of daily living [6]. Improvements in cognitive function would also be expected through BAR [7].

In this study, we conducted intervention based on the principles of BAR for elderly participants with dementia as a randomized controlled trial to prove the effectiveness of BAR.

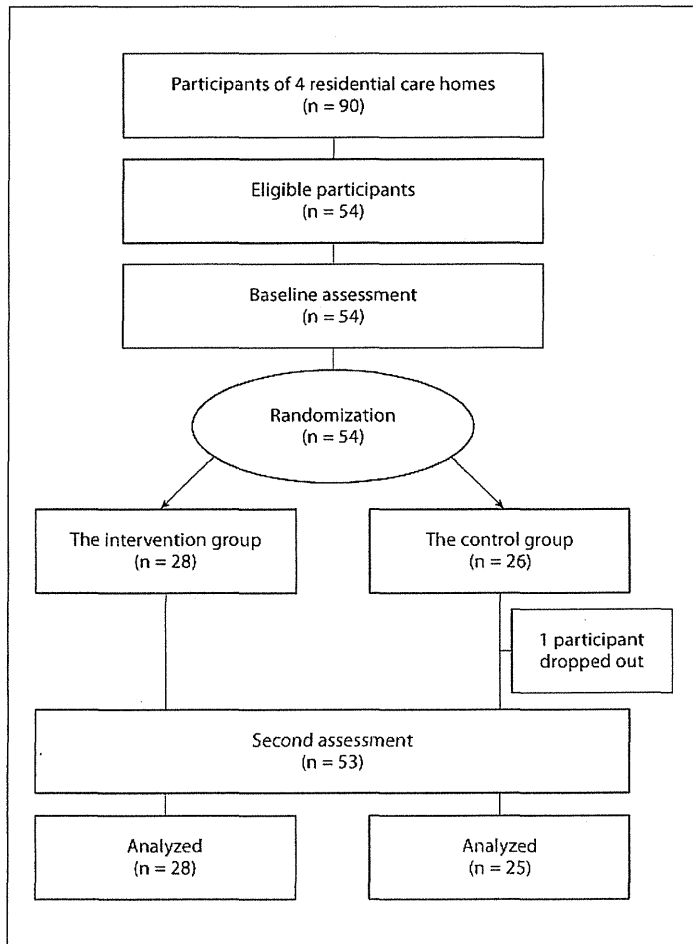
## Methods

### *Participants*

Fifty-four elderly participants in four residential care homes (group living homes) were selected on the basis of the following criteria: (1) being diagnosed with dementia; (2) without severe auditory and visual impairments, and (3) being able to engage in a simple activity or a brief conversation.

### *Randomization*

At the end of the initial baseline assessment, we randomly divided participants into intervention and control groups in each residential care home, so that each intervention or control group was composed of four small groups. We used stratified randomization according to the Hasegawa dementia scale revised (HDS-R) [8], which is similar to mini-mental state examination (MMSE) and has a total score of 30, to equalize the severity of dementia between the two groups. Finally, 54 participants were randomly allocated to the intervention group (n = 28) or control group (n = 26) (fig. 1).



**Fig. 1.** Participant flow diagram.

### *Intervention*

A total of 24 sessions were conducted in each group for 1 h, twice a week, for a 12-week period. In this study, intervention based on principles of BAR combined reality orientation and various activities (e.g. cooking, singing, and sewing) along with reminiscence therapy. In the baseline assessment, we collected information on life histories and specialties from the participants to select enjoyable topics in the sessions (table 1). The intervention staff consisted of one leader and two vice-leaders for each group. The staff of each residential care home had studied the principles of BAR and specifically learned the guidelines about attitude and communication for 4 h, and they played the roles of leader and vice-leaders by rotation. The researcher contributed to serve the same contents of the sessions for four groups. Throughout the session, staff had to accept and share the world of the participants, regardless of whether it was true or not (the first principle: pleasant atmosphere). At the same time, they organized the participants so that each participant could socially interact with other participants (the second principle: communication). When a participant seemed to make a mistake, or not to understand, staff acted to prevent the mistake (the fifth principle: supportive care). After each session, an evaluation meeting was held to improve the skills of the staff. In total, 41 members of staff were involved in the intervention (mean age: 30 years; duration of work experience: 4.9 years; mean number of sessions: 4.5).



**Table 1.** Topics of BAR sessions

Topics	Tools
Cooking rice	rice kettle, furnace, measure, charcoal
Traditional games	beanbag for juggling, cup-and-ball toy, propeller
Pickled vegetables	rice bran, earthenware pot, salt, water
Washing	tub, washing board, washing powder
Sewing duster	cloth, stitch, thread, pincushion
Making rice cakes	mortar, mallet, steam pot, glutinous rice
Rice bran	rice bran, rice bran bag, washbowl
Mortar and pestle	mortar and pestle, taro potato, sesame
Handmade snack	barley flour, rice bowl, spoon
Weaving	silkworm, reel, shuttle
Elementary school	old textbook, pencil, school bag
Making noodles	knead pot, rolling pin, board

In the beginning, the reality orientation method was executed, which provided hints and signs to reconfirm the subjects' orientation in terms of time and date. Then, the reminiscence therapy method was executed. In reminiscence therapy, old-style tools such as a rice kettle, beanbags for juggling, and old textbooks were used, and staff asked the participants about the names of the tools and how to use them. Tools that are familiar to participants provide visual support for enhancing reminiscence. In addition, these tools encompass many activities, from housework to recreation, such as handiwork. These activities using old-style tools recruit procedural memories, which remain after the loss of episodic memory. Therefore, participants gain peace of mind, as they can easily relate to and describe these tools (the fifth principle: supportive care). The participants teach staff how to use these old-style tools. This is role reversal: the participants are teaching the staff who help them in daily living. Through this process, participants were expected to recover their self-confidence and the social function of passing on knowledge to younger generations (the fourth principle: social role). Because of this role reversal, the staff took care to praise the participants naturally (the third principle: praising). Thus, it is expected that participants enjoy the conversations. The control group had no treatment.

#### *Outcome Measures*

Care staff who did not participate in the intervention primarily evaluated participants using two observation scales which were primary outcomes: clinical dementia rating (CDR) [9] and multidimensional observation scale for elderly subjects (MOSES) [10]. CDR is reported to have high reliability (internal consistency: 0.68–0.88). Global severity of dementia was evaluated by the sum of boxes in CDR (CDR-SB) [11]. The CDR-SB sums the ratings in each of six domains ('boxes') of CDR to provide a consensus-based global clinical measure. MOSES is reported to have high reliability (internal consistency: 0.78–0.87). The scale is comprised of 40 parameters in 5 categories of daily life functions: (1) self-care; (2) disorientation; (3) depression; (4) irritability, and (5) withdrawal. Each category's score distribution ranges from 8 to 32 points (1 = not at all; 2 = seldom; 3 = at times; 4 = often) with higher scores indicating more severe disorders [10].

The participants underwent two cognitive tests, which are secondary outcomes: HDS-R and trail making test A [12]. HDS-R was performed to assess global cognitive function. HDS-R correlates well with MMSE, and it is more accurate than MMSE in diagnosing Alzheimer's disease [13]. In addition, HDS-R was shown to be more robust to demographic influences

(age, education level, and gender) than MMSE [14]. Trail making test A was used to evaluate psychomotor speed. Participants were asked to draw a continuous line connecting 25 numbered circles.

After the intervention period, we prepared two questions for staff members: did the participants change after intervention and, if so, how? Did your daily care with the participants change in terms of both physical care and social contact?

#### *Procedure*

This study was approved by the Institutional Research Board of Takasaki University of Health and Welfare (No. 2201). Written consent was obtained from each participant and their families after providing full information regarding the purpose of this study, the risks and benefits, confidentiality, anonymity, and freedom of participation. Participants in the control group were assured that they would receive the same intervention after the intervention period.

#### *Statistical Analysis*

Data of outcome measures before and after intervention were analyzed using the Japanese version of SPSS Statistics for Windows version 18.0 (IBM Corporation, New York, N.Y., USA). Mann-Whitney U test and Fisher's exact test were used for comparison of the two groups at baseline. The primary and secondary statistical hypothesis was that the two observation scales and two cognitive tests would be improved in the intervention group compared with the control group after the intervention period. Repeated measures analysis of covariance (ANCOVA) with the covariates of age and sex was used to analyze the participants at the end of the study. Post hoc analysis for 'between participants' and 'within participants' was conducted with Bonferroni correction.

'Yes' and 'no' answers from the staff were analyzed. Free descriptions were separated into clauses to extract relevant words. We categorized similar words as the same opinion. We counted the number of words in each category.

## **Results**

### *Baseline Characteristics of the Participants*

The study participants were 54 elderly people with dementia (28 in the intervention group and 26 in the control group). No significant difference was found at baseline in any of the demographic variables (table 2).

In the intervention group, no participants dropped out and all took part in  $\geq 20$  of the total of 24 sessions. They looked cheerful and the average attendance rate was high (95.5%). In the control group, 1 participant dropped out due to sickness during the intervention period. Finally, outcome measures were analyzed in 53 participants: 28 participants in the intervention group and 25 in the control group, who completed the second evaluation.

### *Change in the Outcome Measures (table 3)*

Repeated measure ANCOVA showed a significant interaction for total score of CDR-SB ( $F(1, 49) = 7.190, p = 0.015$ ). The control group showed significant deterioration of CDR-SB ( $p = 0.016$ ). On the other hand, the intervention group showed maintenance of this score.

Repeated measure ANCOVA showed a significant interaction for the total score of MOSES ( $F(1, 49) = 4.525, p = 0.038$ ), subscale of disorientation ( $F(1, 49) = 6.453, p = 0.014$ ) and withdrawal ( $F(1, 49) = 4.955, p = 0.031$ ) in daily life functions. In the post hoc analysis, the

**Table 2.** Demographics of the study participants (n = 54)

	Intervention group (n = 28)	Control group (n = 26)	p
Age, years	85.5 ± 4.0	84.9 ± 6.5	0.652
Gender			
Male	1 (3.6)	4 (15.4)	0.153
Female	27 (96.4)	22 (84.6)	
Diagnosis <sup>a</sup>			
AD	18 (64.3)	16 (61.5)	0.334
VD	1 (3.6)	3 (11.5)	
AD and VD mixed	2 (7.1)	0 (0.0)	
FTD	0 (0.0)	2 (7.7)	
Unspecified dementia	7 (25.0)	5 (19.2)	
Donepezil prescribed	9 (32.1)	12 (46.2)	0.403
Psychotropics prescribed	5 (17.9)	10 (38.5)	0.131
Mobility			
Independence	14 (50.0)	15 (57.7)	0.314
Walking aids	9 (32.1)	5 (19.2)	
Wheelchair	5 (17.9)	6 (23.1)	
CDR			
0.5 (questionable)	4 (14.3)	5 (19.2)	0.557
1 (mild)	15 (53.6)	9 (34.6)	
2 (moderate)	7 (25.0)	10 (38.5)	
3 (severe)	2 (7.1)	2 (7.7)	

Values are means ± SD or numbers with percentages in parentheses. Mann-Whitney U test or Fisher's exact test were used. AD = Alzheimer's disease; VD = vascular dementia; FTD = frontotemporal dementia. <sup>a</sup> Clinical diagnosis assigned according to the notes of participants' consultant physicians.

control group showed a tendency of deterioration (subscale of disorientation,  $p = 0.054$ , and withdrawal,  $p = 0.095$ ), but there was no significant difference. The intervention group had significantly lower scores for total score of MOSES ( $p = 0.048$ ) and subscale of withdrawal ( $p = 0.008$ ) than the control group after intervention.

There were no significant effects on the two cognitive tests of HDS-R and trail making test A.

#### Staff Interview

In terms of changes seen in the intervention group, 26 (63.4%) of the 41 staff members noticed a positive change. Staff opinions were as follows: 'improved peer relationships' (n = 12), 'a more cheerful and positive outlook' (n = 11), 'positive anticipation of session' (n = 6), and 'co-operative attitude toward the care staff' (n = 4). In terms of changes in staff, 31 (75.6%) of the 41 staff members noticed a change. Staff opinions were as follows: 'I began to listen to the participants' recollections of their younger days' (n = 16), 'I learned how to communicate with the participants in a positive manner' (n = 10), 'I learned the importance of role reversal by being taught new things by the participants' (n = 6), 'I noticed for the first time the abilities of the participants' (n = 4), and 'I learned the importance of expressing appreciation when tasks are completed well' (n = 3).

**Table 3.** Change in outcome measures for the intervention (n = 28) and control groups (n = 25)

Outcome variable	Time period				Interaction		Post hoc analysis
	before test		after test		F	p	p
	mean ± SD	p	mean ± SD	p			
CDR-SB							
Intervention	8.0 ± 3.8		7.6 ± 3.5		7.190	0.015*	0.296
Control	8.5 ± 4.5	0.684	9.3 ± 4.8	0.200			
MOSES total							
Intervention	71.4 ± 12.7		69.3 ± 15.4		4.525	0.038*	0.105
Control	76.8 ± 16.4	0.200	78.7 ± 16.6	0.048*			
MOSES self-care							
Intervention	14.0 ± 4.1		13.8 ± 5.2		0.405	0.527	0.692
Control	15.7 ± 5.7	0.226	15.9 ± 5.8	0.186			
MOSES disorientation							
Intervention	18.8 ± 4.1		18.2 ± 4.6		6.453	0.014*	0.105
Control	18.6 ± 6.1	0.964	19.4 ± 6.4	0.407			
MOSES depression							
Intervention	11.2 ± 3.4		10.9 ± 3.2		0.101	0.752	0.602
Control	12.0 ± 4.9	0.394	11.5 ± 5.0	0.521			
MOSES irritability							
Intervention	11.0 ± 2.7		10.8 ± 3.2		1.159	0.287	0.630
Control	11.3 ± 2.8	0.926	11.7 ± 3.3	0.488			
MOSES withdrawal							
Intervention	16.4 ± 5.4		15.5 ± 5.7		4.955	0.031*	0.146
Control	19.1 ± 5.4	0.104	20.2 ± 5.4	0.008*			
HDS-R							
Intervention	13.1 ± 4.5		13.4 ± 4.6		0.078	0.781	0.722
Control	12.6 ± 5.8	0.768	13.0 ± 6.2	0.903			
TMT-A							
Intervention	177.9 ± 94.7		171.2 ± 96.6		0.128	0.722	0.901
Control	218.2 ± 118.5	0.300	229.6 ± 145.1	0.252			

Repeated measures ANCOVA with the covariates of age and sex was used, and post hoc analysis with Bonferroni correction was conducted. TMT-A = Trail making test A. \* p < 0.05.

## Discussion

The results indicate the effect of intervention based on the principles of BAR on the improvement or maintenance of two observation scales, CDR-SB and MOSES, especially disorientation and withdrawal, although no improvement was shown in terms of the two cognitive tests of HDS-R and trail making test A. In a previous randomized controlled trial, the effect of a group care program, which consisted of reminiscence and reality orientation, was examined using an observation scale (MOSES) and a cognitive test (MMSE) as outcome measures [15]. The study found improved orientation and withdrawal subscales of MOSES, agreeing with our current study. In a randomized controlled trial on 168 demented elders in nursing homes, a comprehensive program of counseling, life review, interpersonal therapy, behavioral therapy, and rehabilitation reduced multiple psychiatric symptoms, suggesting the importance of a person-oriented approach [16]. Activities adjusted to 'personality style of interest' reduced agitation and passivity of demented elders. Furthermore, the activities adjusted to both functional level and personality style of interest brought greater pleasure

than activities partially adjusted or non-adjusted to individual preferences and needs [17]. In the current study, we tried to adapt the contents of the sessions to each participant by collecting information on life history, although intervention sessions were conducted in a group setting.

Due to the basis of the 5 principles of BAR, participants looked cheerful and the average attendance was extremely high (95.5%). When the staff took care of the participants by following the principles of BAR, staff became more receptive and provided care that encouraged demonstration of each participant's abilities. The responses to questions by the staff also supported these findings. Intervention with BAR principles enhanced understanding between staff and participants, as well as between participants [6]. The benefit was generalized to participants' daily life. Therefore, participants may gain a sense of self-worth and a desire to live, and the behavioral and psychological symptoms of the participants may be reduced. In fact, in this study, withdrawal was alleviated. Intervention following the BAR principles also improved apathy and social ability in elderly participants with mild cognitive impairment and mild dementia [18]. The concept of person-centered care can be described as follows: it acknowledges that the individual is a person who can experience life and relationships, despite progressive disease; involves inclusion of the person's past life and history in their care, and it focuses on what the person can do, rather than abilities that have been lost owing to the disease [19]. The concept of person-centered care is widely accepted in the field of dementia care. BAR is also a concept but not a technique. We expect BAR to be widely accepted in the field of dementia rehabilitation.

Our randomized controlled trial revealed that intervention based on BAR principles promoted intersubjectivity between participants and therapists/care staff and was effective for maintaining and improving emotional and daily life functions in the current study. Participants may regain their confidence. BAR principles of enjoyable stimulation, communication, and role reversal contribute to providing an environment where elderly participants with dementia can laugh and be themselves.

We revealed the effectiveness of dementia rehabilitation based on the principles of BAR by a randomized controlled trial. A pleasant atmosphere, communication, praising, social role, and supportive care are essential in rehabilitation for dementia.

### Acknowledgements

We thank the participants in this study, as well as the care staff in residential care homes, for their contribution. T.Y. was supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Science, Sports, Culture and Technology, Japan (22700529). H.Y. is supported by Grants-in-Aid for Scientific Research from the Ministry of Education, Science, Sports, Culture and Technology, Japan (23300197 and 22650123), and a Grant-in-Aid for Scientific Research (H22-Ninchisho-Ippan-004) from the Ministry of Health, Labor and Welfare of Japan.

### Disclosure Statement

The authors declare that they have no conflicts of interest.

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# Communicative Competence in Alzheimer's Disease: Metaphor and Sarcasm Comprehension

American Journal of Alzheimer's  
Disease & Other Dementias®  
00(0) 1-6  
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sagepub.com/journalsPermissions.nav  
DOI: 10.1177/1533317512467677  
<http://aja.sagepub.com>

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## Abstract

The purpose of this study was to evaluate the deficits of metaphor and sarcasm comprehension in Alzheimer's disease (AD), as pragmatic interpretation such as metaphor and sarcasm comprehension is required in social communication. A total of 31 young normal controls, 104 aged normal controls (ANC), 42 patients with amnesic mild cognitive impairment (aMCI), and 30 patients with mild AD were evaluated by Metaphoric and Sarcastic Scenario Test, which consists of 5 metaphoric and 5 sarcastic questions with 5 answer choices. Scores were analyzed using the repeated measures analysis of variance (metaphor/sarcasm vs 4 participant groups). Sarcasm comprehension, which requires second-order Theory of Mind (ToM), started to deteriorate in ANC, and metaphor comprehension, which requires first-order ToM, started to deteriorate in aMCI, and both deteriorated as disease progressed. Literal interpretation of pragmatic language is characteristic in patients with mild AD. Such misinterpretation would result in social miscommunication, even if they still retained semantic-lexical competence.

## Keywords

Alzheimer's disease, theory of mind, empathy, communication difficulties, pragmatic competence

## Introduction

Communicative competence occupies a central place in participation in social activities and it can be impaired in patients with Alzheimer's disease (AD). In AD, lexical-semantic competence is deteriorated as a result of cognitive decline.<sup>1</sup> However, patients could also have communicative difficulties even from the stage where lexical-semantic competence is still preserved. In social communication, literal lexical-semantic comprehension is not sufficient.<sup>2</sup> Comprehension of nonliteral implication is often required to infer a speaker's intended meaning (Theory of Mind [ToM]),<sup>3</sup> which is not always expressed explicitly.

Theory of Mind is considered to consist of 2 stages, first-order ToM is the ability to grasp the intentions of the speaker and second-order ToM is the ability to infer the speakers' evaluation for an attributed thought.<sup>4-7</sup> Metaphor and sarcasm comprehension are considered to be appropriate materials of ToM.<sup>8</sup> First-order ToM is sufficient for metaphor comprehension.<sup>9</sup> Metaphor suggests meanings through mental linkage and comparison of similarities between different expressions normally not related to each other.<sup>10,11</sup> Second-order ToM is required for sarcasm comprehension.<sup>5</sup> Sarcasm expresses something other than explicitly stated and especially the opposite of the literal meaning of the utterance.<sup>12</sup> Thus comprehension of sarcasm requires the ability to reflect on the speakers' evaluation about the attributed thought, adding to utterance intention.<sup>4</sup>

Metaphoric and sarcastic competence has been mainly studied to evaluate the social communicative competence in the phases of development and its disorders,<sup>13</sup> as interaction with other people is critical for normal neurocognitive development.<sup>14</sup> In the phase of aging and degeneration, it is also meaningful to evaluate the decline of social communicative competence. However, a recent review on nonliteral language in AD noted a severe lack of evidence.<sup>15</sup> Furthermore, previous reports on metaphor and sarcasm comprehension are inconsistent; for example, deficits in metaphor comprehension were reported from early stages of AD,<sup>16-18</sup> whereas concerning irony and sarcasm, previous studies did not find a significant impairment relative to an aged control group,<sup>19,20</sup> which is surprising because irony involves more cognitive processes than metaphor.<sup>21</sup>

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The controversy could be partly due to the material in the test; it is a prerequisite that difficulty level of lexical-semantic aspects is even among sentences used in the tests. Thus, we conducted the present study to evaluate the deficits of metaphor and sarcasm in AD using a questionnaire that consists of the same type of sentences with similar difficulty levels and whose efficacy was validated for differential diagnosis of developmental disorders in children.<sup>22</sup> For a better understanding of characteristics of AD, error patterns were analyzed. We hypothesized that comprehension might be deteriorated at the early stages of disease and sarcasm comprehension might be deteriorated earlier than metaphor comprehension.

## Methods

### Participant

The participants were 31 young normal controls (YNC), 104 aged normal controls (ANC), 42 patients with amnesic mild cognitive impairment (aMCI), and 30 patients with mild AD in Clinical Dementia Rating scale (CDR) 1. The YNC were university students and ANC were recruited from community dwellers, who underwent clinical interviews by a clinician who specialized in evaluation of dementia. Patients were recruited from the outpatient clinics. The exclusion criteria were psychiatric diseases and delirium. Verbal incomprehension was also an exclusion criterion. The participants were required to read out the questions and those who lacked fluency were excluded. Concerning language ability, the participants received the Mini-Mental State Examination (MMSE) and were confirmed to have the capacity to name simple objects, repeat phrases, follow written commands, and write a sentence with a noun and a verb. The participants were diagnosed based on the criteria for AD by National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association<sup>23</sup> and on the criteria for aMCI by the report of the International Working Group on Mild Cognitive Impairment.<sup>24</sup> Patients with aMCI were limited to those free from objective symptoms of other types of dementia such as dementia with Lewy bodies or frontotemporal dementia. The Ethics Board of the Gunma University School of Health Sciences approved all procedures (No. 21-26), and written informed consent was obtained from all the participants.

### Task

Metaphor and sarcasm comprehension was evaluated by the Metaphoric and Sarcastic Scenario Test (MSST), which was developed for discrimination of high functioning pervasive developmental disorders from attention deficit/hyperactivity disorders in young children.<sup>22</sup> This test consists of 5 metaphoric and 5 sarcastic sentences; metaphoric sentences are odd numbered and sarcastic sentences even. The words and sentences in MSST were selected from standard textbooks of Japanese language (Mitsumura Press) for 1st, 2nd, and 3rd grades in elementary school. Therefore, the lexical-semantic components were not above the levels for those who completed

6 years of elementary school education. The test employed a multiple-choice style, that is, 1 choice was correct and 4 were incorrect. The wrong choices included a literal interpretation, an answer associated with part of the sentence, misunderstanding of the sentence, and not knowing. The number of correct answers represented the metaphor score and sarcasm score, respectively. Each pattern of incorrect answers was totaled. Cognitive performance was assessed using MMSE.

### Analysis

Group comparison of scores and the 4 error scores were conducted using the repeated measures analysis of variance (metaphor/sarcasm vs 4 participant groups).

Among aged groups, we conducted the repeated measures analysis of covariance (metaphor/sarcasm vs 3 participant groups) with covariates of age, sex, education, and MMSE scores. A post hoc test was conducted with multiple comparisons with Bonferroni correction. All analyses were conducted using the Japanese version of SPSS for Windows version 19.0 (IBM Corporation, New York). Significance was set as  $P < .05$ .

## Results

Demographic scores are shown in Table 1. The results of the MSST are shown in Table 2 and Figure 1. The main effect indicated that sarcasm was more difficult to comprehend than metaphor ( $F_{1,203} = 54.634, P < .001$ ), and interaction with participant groups was also significant ( $F_{3,203} = 3.354, P = .020$ ). According to within-subject post hoc analysis, no significant difference was observed between metaphor and sarcasm scores in YNC ( $P = .442$ ), whereas in ANC, aMCI, and mild AD, scores of sarcasm was significantly lower than that of metaphor ( $P < .001$  in all the groups). According to between-subject post hoc analysis, metaphor scores were not different between YNC and ANC, whereas metaphor scores were significantly better in ANC than in aMCI ( $P = .011$ ) and in aMCI than mild AD ( $P < .001$ ). Sarcasm scores were significantly better in YNC than in ANC ( $P = .040$ ), in ANC than in aMCI ( $P = .005$ ), and in aMCI than in mild AD ( $P = .002$ ).

Concerning the error patterns, group differences were observed only in literal interpretation and there were no group differences in the other 3 error patterns (an answer associated with a part of the sentence, misunderstanding of the sentence, and not knowing; Table 3, Figure 2). The main effect was significant ( $F_{1,203} = 34.283, P < .001$ ) and interaction was also significant ( $F_{3,203} = 6.887, P < .001$ ). According to the between-subject post hoc analysis, errors of literal interpretation of metaphor and sarcasm comprehension were not different between YNC and ANC ( $P = 1.000$  in both), and ANC and aMCI ( $P = .115, P = .349$ , respectively), whereas a significant difference was observed between aMCI and mild AD ( $P < .001$  in both). According to within-subject post hoc analysis, the errors of literal interpretation were more in sarcasm than in metaphor in aMCI ( $P = .038$ ) and in mild AD ( $P < .001$ ), whereas there was no significant difference in YNC ( $P = .187$ ) and in ANC ( $P = .072$ ).



**Table 1.** Demographic Data<sup>a</sup>

	n	Age	Gender	Education	MMSE
		Mean $\pm$ SD	Male, Female	Mean $\pm$ SD	Mean $\pm$ SD
YNC	31	19.3 $\pm$ 1.4	M10, F21	13.3 $\pm$ 0.6	
ANC	104	72.1 $\pm$ 4.2	M25, F79	12.0 $\pm$ 2.3	28.4 $\pm$ 1.4
aMCI	42	74.0 $\pm$ 5.4	M18, F24	11.1 $\pm$ 3.0	25.8 $\pm$ 1.7
AD	30	78.0 $\pm$ 7.2	M6, F24	9.3 $\pm$ 2.3	21.4 $\pm$ 4.0

Abbreviations: YNC, young normal controls; ANC, aged normal controls; aMCI, amnesic mild cognitive impairment; AD, patients with mild Alzheimer's disease in clinical dementia rating 1; MMSE, Mini-Mental State Examination; SD, standard deviation.

<sup>a</sup> The rate of gender difference was not different among the groups ( $P = .088$ , chi-squared statistic). Concerning age, there was no difference between ANC and aMCI, but patients with mild AD were significantly older than ANC and aMCI ( $P < .001$ ,  $P = .004$ , respectively). Concerning years of education, there was not difference between ANC and aMCI, but patients with mild AD received significantly shorter education than the patients with ANC and aMCI did ( $P < .001$ ,  $P = .006$ , respectively). Scores of MMSE was significantly different among groups ( $P < .001$ , among all the groups).

**Table 2.** Correct Answers

	Metaphor		Sarcasm		P
	Mean $\pm$ SD	P Value <sup>a</sup>	Mean $\pm$ SD	P Value <sup>a</sup>	
YNC	5.0 $\pm$ 0.2		4.8 $\pm$ 0.4		.442
YNC vs ANC		1.000		.040*	
ANC	4.8 $\pm$ 0.7		4.1 $\pm$ 1.2		<.001**
ANC vs aMCI		.011*		.005*	
aMCI	4.3 $\pm$ 1.2		3.4 $\pm$ 1.3		<.001**
aMCI vs AD		<.001**		.002*	
AD	3.3 $\pm$ 1.2		2.3 $\pm$ 1.6		<.001**

Abbreviations: YNC, young normal controls; ANC, aged normal controls; aMCI, amnesic mild cognitive impairment; AD, patients with mild Alzheimer's disease in clinical dementia rating 1; SD, standard deviation.

<sup>a</sup> The difference among groups analyzed by between-subject post hoc analysis of  $2 \times 4$  analysis of variance (metaphor and sarcasm; 4 groups).

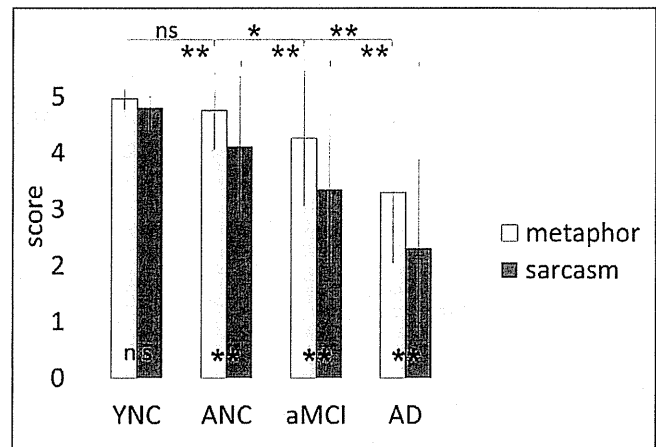
<sup>b</sup> The difference between metaphor and sarcasm analyzed by within-subject post hoc analysis of  $2 \times 4$  analysis of variance (metaphor and sarcasm; 4 groups).

\*  $P < .05$ .

\*\*  $P < .001$ .

There was weak correlation between MMSE scores and metaphor ( $r = .362$ ,  $P < .001$ ) and sarcasm scores ( $r = .337$ ,  $P < .001$ ).

The difference among the aged groups of ANC, aMCI, and mild AD remained by the repeated measures analysis of covariance with covariates of age, sex, education, and MMSE scores. According to within-subject post hoc analysis, in ANC, aMCI, and mild AD, scores of sarcasm was significantly lower than that of metaphor ( $P < .001$ ,  $P < .001$ ,  $P = .004$ , respectively). According to between-subject post hoc analysis, metaphor scores were significantly better in ANC than in aMCI ( $P = .040$ ) and in aMCI than mild AD ( $P = .002$ ). Sarcasm comprehension was significantly better in ANC than in aMCI ( $P = .021$ ) and in aMCI than in mild AD ( $P = .023$ ).



**Figure 1.** Scores of correct answers. Sarcasm scores were significantly lower in ANC than YNC, whereas metaphor scores were not different between the 2 groups. Metaphor scores were deteriorated from MCI. Post hoc analysis of  $2 \times 4$  analysis of variance (metaphor and sarcasm; 4 groups) was conducted; \* in upper row indicates statistical significance of between subject analysis of metaphor, \* in middle row indicates that of sarcasm, and \* in the bottom row indicates statistical significance calculated by intrasubject analysis. \* $P < .05$ ,  $P < .001$ . YNC indicates young normal controls; ANC, aged normal controls; aMCI, amnesic mild cognitive impairment; AD, patients with mild Alzheimer's disease in clinical dementia rating 1.

**Table 3.** Errors of Literal Answers

	Metaphor		Sarcasm		
	Mean $\pm$ SD	P Value <sup>a</sup>	Mean $\pm$ SD	P Value <sup>a</sup>	P Value <sup>b</sup>
YNC	0.00 $\pm$ 0.00		0.19 $\pm$ 0.40		.187
YNC vs ANC		1.000		1.000	
ANC	0.05 $\pm$ 0.21		0.19 $\pm$ 0.44		.072
ANC vs aMCI		.115		.349	
aMCI	0.21 $\pm$ 0.47		0.48 $\pm$ 0.77		.038*
aMCI vs AD		<.001**		<.001**	
AD	0.87 $\pm$ 0.82		1.77 $\pm$ 1.72		<.001**

Abbreviations: YNC, young normal controls; ANC, aged normal controls; aMCI, amnesic mild cognitive impairment; AD, patients with mild Alzheimer's disease in clinical dementia rating 1; SD, standard deviation.

<sup>a</sup> The difference among groups analyzed by between-subject post hoc analysis of  $2 \times 4$  analysis of variance (metaphor and sarcasm; 4 groups).

<sup>b</sup> The difference between metaphor and sarcasm analyzed by within-subject post hoc analysis of  $2 \times 4$  analysis of variance (metaphor and sarcasm; 4 groups).

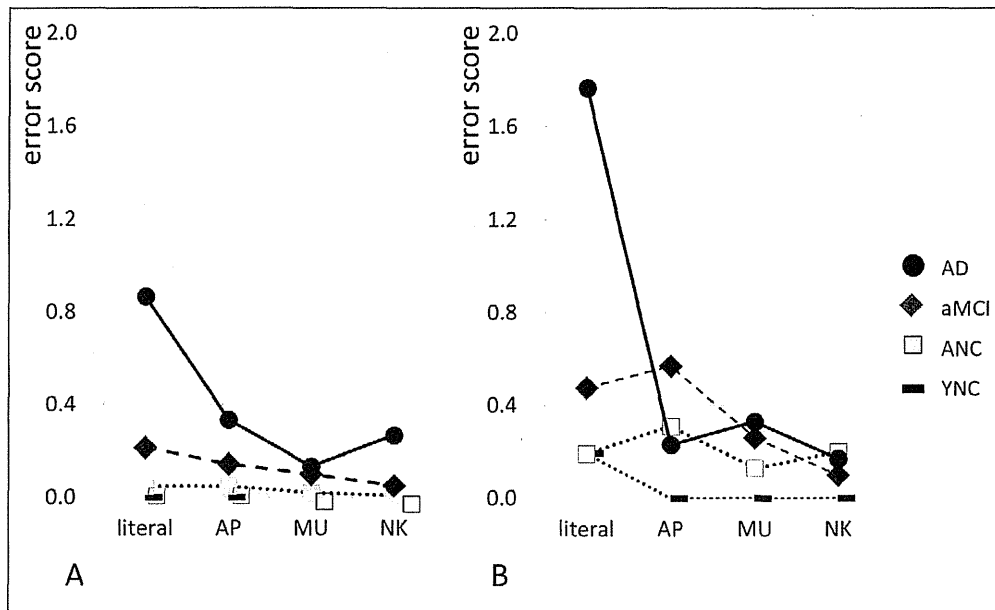
\*  $P < .05$ .

\*\*  $P < .001$ .

## Discussion

Scores for both metaphor and sarcasm were not significantly different from each other in YNC, which confirmed that the difficulty level of metaphor and sarcasm comprehension tested by MSST was not different, at least among young participants.

The result suggested that deterioration of sarcasm comprehension was an age-related change. Sarcasm scores were



**Figure 2.** Error patterns. Error patterns of metaphor (A) and sarcasm (B). Significant differences among groups were observed in literal errors in both metaphor and sarcasm and the other 4 patterns of error were not significantly different among groups. AD indicates patients with mild Alzheimer's disease in clinical dementia rating I; aMCI, amnesic mild cognitive impairment; ANC, aged normal controls; YNC, young normal controls; literal, literal interpretation; AP, answers associated with part of the sentence; MU, misunderstanding of the sentence; NK, not knowing.

significantly lower in ANC than in YNC, whereas no difference was observed in metaphor comprehension. Empirical developmental studies of normal children have found that metaphors are comprehended at an earlier age than ironies.<sup>4</sup> One factor critical for understanding verbal irony (sarcasm) is an individual's ability to attribute appropriate second-order ToM.<sup>4</sup> The success of the second-order ToM task emerges at around age 5 or 6<sup>25</sup> and it has been revealed that age-related decline occurred directly in the second-order ToM and indirectly in the first-order ToM.<sup>26</sup> The influence of difference in difficulty level could not be ruled out. Colston and Gibbs have shown that it takes healthy adults longer to read ironic than metaphoric statements, which suggests that irony (sarcasm) processing requires more cognitive load than metaphor processing.<sup>5</sup>

Age-related decline in metaphor comprehension was not shown in the present study. The deterioration was reported in the early stage of AD by a study that did not include the participants with MCI,<sup>16-18</sup> and the present study showed that comprehension begins to decline even during aMCI, the prodromal stage of AD.

Another issue was with the comprehension of conventional metaphor. In the present study, conventional metaphor comprehension was deteriorated as well as nonconventional novel expressions, as shown in previous studies.<sup>16,17</sup> However, Amanzio et al reported the deficits in nonconventional novel metaphors, while no impairment was observed in conventional metaphors.<sup>18</sup> The study assumed that conventional metaphors might be interpreted automatically through frequent usage, whereas novel metaphors recruited ToM

processes. However, the patients might tend to avoid complicated pragmatic wording and without usage in everyday speech, conventional metaphors could recruit ToM processes as novel metaphors.

Deficits of AD were characterized by literal interpretation; concerning error patterns, group differences were observed only in the pattern of literal interpretation. Decline of inhibition could be related to choosing literal interpretation. Metaphor and sarcasm comprehension requires contextual coherence judgment, as literal interpretation can be taken out of context. It has been proposed that both the literal and the nonliteral meaning are activated concurrently and the inappropriate meaning is inhibited by the context.<sup>27-31</sup> However, patients with AD had difficulty suppressing inappropriate literal interpretation, which is concurrently activated.<sup>32,33</sup> Literal interpretation of metaphor causes misunderstanding and that of sarcasm could be more problematic. In sarcastic expression, the speakers say the opposite of what they mean<sup>15</sup> and thus the patients with AD may interpret the utterance as admiration, which would be opposite to the speakers' intention. Such misinterpretation would result in social miscommunication.

Miscommunication between patients and caregivers could lead to behavioral and psychological symptoms of dementia (BPSD) in patients and distress in caregivers.<sup>34-37</sup> Therefore, caregivers' understanding of decreased communication abilities in patients may reduce BPSD and caregiver distress.<sup>38,39</sup>

As a limitation, the groups of the present study were not matched for age and education. Based on the results of the present study, further study is required with a larger group of participants for consideration of clinical relevance.

## Acknowledgments

The authors thank all the study participants, Dr Masamitsu Takatama, Geriatrics Research Institute and Hospital, Maebashi, and Rumi Shinohara and Yuko Tsunoda, at the Gunma University, Maebashi, for their support.

## Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research and/or authorship of this article: Dr Yamaguchi is supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Science, Sports, Culture and Technology, Japan (23300197 and 22650123) and a Grant-in-Aid for Scientific Research (H22-Ninchisho-Ippan-004) from the Ministry of Health, Labor and Welfare, Japan.

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