The Effectiveness of Training Programs on the Fidelity of Neuropsychological Tests

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ABSTRACT

Background There will probably be an exponential increase in the number of seniors suffering from dementia, as aging is the greatest risk factor for this disease. Therefore, neuropsychological tests to assessing dementia are likely to play an increasingly important role for medical services in Japan. This study developed and evaluated the usefulness of a training program on neuropsychological tests aimed at promoting the understanding of testers with regard to the cognitive functions and communication required in the neuropsychological testing process.

Methods The subjects of this study comprised 20 individuals engaged in administrating neuropsychological tests at the Japan-Multidomain Intervention Trial for Prevention of Dementia in Older Adults with Diabetes. A four-hour training session was held. The first part of the training program focused on "cognitive functions and communication;" the second addressed "neuropsychological tests." As the main evaluation criteria, a fidelity checklist was created with 14 items designed to measure success or failure with regard to important and easily mistakable aspects of implementing each neuropsychological test. They were conducted three times: before, immediately after, and six months after the training.

Results The main effect of time was significant for the "fidelity" score. The effect size was large at $\eta^2 = 0.69$. A simple main effect test using the Bonferroni method revealed significant differences between the pre-training and post-training values and between the pre-training and six-month point values. However, no significant differences were found in self-efficacy scores before, immediately after, and six months after the training.

Conclusion This outcome indicates that the fidelity of the subjects to neuropsychological tests increased as a result of the training program, and that this improvement was maintained through the six-month period following the program. Moreover, the large effect size suggests that the training program may be effective in facilitating the mastery of neuropsychological tests in testers.

Key words cognitive functions; communication; fidelity; training program on neuropsychological test

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Abbreviations: ADAS, Alzheimer's Disease Assessment Scale; J-MIND-Diabetes, the Japan-Multidomain Intervention Trial for Prevention of Dementia in Older Adults with Diabetes; MMSE, the Mini-Mental State Examination; MoCA, the Montreal Cognitive Assessment; WAIS-III, the Wechsler Adult Intelligence Scale Third Edition; WMS-R, the Wechsler Memory Scale-Revised

The number of people in Japan aged 65 or older in fiscal year 2018 was 35.58 million, or 28.1% of the total population.[1] The population growth in the 65-to-74 age group is expected to level off in the future as the population of latter-stage elderly seniors aged 75 or older is expected to grow. Thus, there will probably be an exponential increase in the number of seniors suffering from dementia, as aging is the greatest risk factor[2] for this disease. Therefore, neuropsychological tests to assessing dementia are likely to play an increasingly important role for medical services in Japan.

Neuropsychological tests are administered to seniors for three purposes. The first objective is to screen for dementia. The revised version of Hasegawa's Dementia Scale[3] and the Mini-Mental State Examination (MMSE)[4] are currently the most widely used tests in Japan. In recent times, many opportunities to use the Montreal Cognitive Assessment (MoCA)[5] to screen for mild cognitive impairments have also been identified in Japan to act early to prevent dementia. The second intention of administering neuropsychological tests is to identify variations in the diverse aspects of cognitive functioning among seniors. Tests such as the Neurobehavioral Cognitive Status Examination[6] and the Wechsler Adult Intelligence Scale Third Edition (WAIS-III)[7] are used in this context. The third aim is to gauge the level and characteristics of individual cognitive functions. Among other examinations, the Frontal Assessment Battery[8] is used to assess frontal lobe functions, the Trail Making Test[9] to assess attentional functions, and the Wechsler Memory Scale-Revised (WMS-R)[10] to measure memory.

Since all neuropsychological tests focus on various different cognitive functions such as memory, attentional tasks, and executive function, the test structures are often complex. Further, since many neuropsychological tests express their results as scores, testers tend to focus on the tallies over other aspects. However, it is also important to examine the reactions of test subjects qualitatively because the way in which subjects respond to neuropsychological tests also reflects their cognitive functioning. Thus, it is essential for testers to understand the cognitive functions in advance when implementing neuropsychological tests. Such tests take a considerable amount of time to administer.[11] Moreover, the testing has the potential to damage the self-esteem of elderly subjects if they are unable to respond when the test is conducted. The decline of physical functions such as hearing and vision, and the elderly group's susceptibility to fatigue also greatly influence the results of neuropsychological tests.[12] Therefore, when conducting neuropsychological tests on seniors, a tester must consider myriad factors and communicate with the subject in a manner that ensures that the process is not invasive. Since these circumstances can impede the tester during the application of the neuropsychological tests, specialists may often feel that they lack the requisite skills to conduct these tests.

Given that the number of seniors with dementia is likely to increase manifold in the future, the task of training individuals who can smoothly implement neuropsychological tests is a critical challenge for Japanese healthcare. To this end, the mastery of neuropsychological tests can be promoted by arranging for opportunities for testers to learn about cognitive functions and communication. However, no training programs have yet focused on cognitive functions and communication pertaining to expertise in administering neuropsychological tests and no extant research has examined the effects of such an attempt. This study developed and evaluated the usefulness of a training program on neuropsychological tests aimed at promoting the understanding of testers with regard to the cognitive functions and communication required in the neuropsychological testing process. Fidelity to neuropsychological tests was used as the main evaluation criteria in determining the usefulness of the program. Fidelity is defined as the degree to which a program is implemented as intended.[13] Fidelity is often used when considering whether psychological interventions are being implemented properly, but psychological tests have not been considered so far. Since we thought that it was very important to conduct the neuropsychological tests according to the procedure, we decided to evaluate fidelity. In addition, fidelity was considered appropriate as the primary criterion for the assessment of the usefulness of the training program because the measurement of fidelity to established procedures also simultaneously enabled the evaluation of the level of mastery of the tester in administering the neuropsychological tests on subjects.

SUBJECTS AND METHODS

Subjects

The subjects of this study comprised 20 individuals engaged in administrating neuropsychological tests at the Japan-Multidomain Intervention Trial for Prevention of Dementia in Older Adults with Diabetes (J-MIND-Diabetes). This trial is currently being conducted by the Sakurai Group of the National Center for Geriatrics and Gerontology in Japan. The average age of the testers was 43.3 years (±10.4 years), and their average years of neuropsychological testing experience were 5.4 (±6.9). By occupational category, four of the subjects were physicians, 13 were psychologists, and three were research assistants.

The Training Program on Neuropsychological Tests

A four-hour training session was held on January 26, 2019 at a training center at the National Center for Geriatrics and Gerontology. The first part of the training program focused on "cognitive functions and communication;" the second addressed "neuropsychological tests."

The section on "cognitive functions and communication" included the following content. For cognitive functions, the training addressed the key functions assessed in neuropsychological tests such as memory, executive function, and attentional functions. Among these, memory was classified as immediate memory, recent memory, and remote memory, after which working memory was explained. Baddely's model[14] was explained to teach working memory: the instructors emphasized that since working memory is a function that originates in the frontal lobe, it can be impaired even if recent memory remains intact. The process of the executive function was explained on the basis of the concept of a higher-order cognitive function that controls independent cognitive functions. The executive function was organized into the five phases of "grasping the situation," "setting goals," "planning," "implementing the plan," and "evaluating the results."[15] The four components of attentional functions were outlined: sustained attention, selective attention, divided attention, and alternative attention. Specific examples were provided for all functions to promote understanding among the subjects and to illustrate how each function is reflected in daily life. This elucidation was followed by an overview that clarified the cognitive function(s) assessed by specific neuropsychological tests, which were further explained in detail in the second part of the training. The segment on communication encompassed five interpersonal communication skills that would not make the test subject feel uncomfortable: "communicating slowly," "communicating what will happen next," "communicating succinctly in small chunks," "communicating in concrete terms," and "drawing attention" in communication. It was explained with reference to specific cases that since these ways of communicating do not harm the self-esteem of the subject, and because they take physiological decline due to aging into account, they are not invasive for seniors and enable the tester to appropriately assess the subject's cognitive functions.

For the training on "neuropsychological tests," a manual was prepared for the examinations used in J-MIND-Diabetes — specifically, MMSE,[4] MoCA,[5] WMS-R Logical Memory,[10] Rey–Osterrieth Complex Figure Test,[16] Alzheimer's Disease Assessment Scale (ADAS),[17] WAIS-III Digit Span,[7] Trail Making Test,[9] and Letter Fluency[18] — and the implementation and scoring methods of these tests were explained. Scoring exercises were conducted for the Rey–Osterrieth Complex Figure Test using a simulated case.

Evaluation Criteria

The following criteria were used in the evaluation: (a) was conducted once only, before the training; (b) and (c) were conducted three times: before, immediately after, and six months after the training. These questionnaires were collected from subjects in person before and immediately after the training and then collected by mail six months after the training.

(a) Basic attributes

Subjects were asked to indicate their age, years of neuropsychological testing experience, and occupational category.

(b) Fidelity to neuropsychological tests

As the main evaluation criteria, a fidelity checklist (hereafter "fidelity") was created with 14 items designed to measure success or failure with regard to important and easily mistakable aspects of implementing each neuropsychological test (Table 1). When preparing fidelity checklists, researchers specializing in neuropsychological tests examined easily mistakable points and important procedural points when implementing each neuropsychological test, and then used these as question items. The subjects were instructed to check "○" if they thought the statement was correct, "×" if they thought it was incorrect, and "I don't know" if they did not know. One point was awarded for each correct answer, and no points were awarded for incorrect or "I don't know" answers. The fidelity score range was 0 to 14, and a higher score indicated that the subject evinced higher fidelity to the neuropsychological tests.

(c) Self-efficacy pertaining to neuropsychological tests

As a secondary evaluation criteria, subjects were presented with the following six statements designed to measure their self-efficacy with regard to neuropsychological tests: statement 1: "I am interested in clinical geriatrics" (hereafter "interest in clinical geriatrics"); statement 2: "I understand the basic cognitive functions assessed by neuropsychological tests" (hereafter "understanding of cognitive functions"); statement 3: "I understand neuropsychological tests that assess memory, attentional functions, and executive function" (hereafter "understanding of neuropsychological tests"); statement 4: "I can smoothly implement one neuropsychological test" (hereafter "smooth implementation of one test"); statement 5: "I can implement neuropsychological tests without making the subject feel bad" (hereafter "non-invasive implementation of tests"); and statement 6: "I can smoothly implement multiple neuropsychological tests in combination" (hereafter "smooth implementation of multiple tests"). Researchers specializing in neuropsychological tests examined self-efficacy, which is considered important when conducting neuropsychological tests, and then compiled the data as question items. Subjects were required to rate themselves on each statement on a five-point scale from "not true at all" (0 points) to "very true" (4 points).

Statistical Analysis

One-way analysis of variance was conducted to investigate the differences in scores before, immediately after, and six months after the training. The eta-squared value (η^2) was calculated to measure the effect size in cases where main effects were confirmed. At the same time, to investigate the association between fidelity and self-efficacy, Spearman's rank correlation coefficient was calculated for the pre-training fidelity and each self-efficacy scale.

Ethical considerations

Participants received an overview of the study and written explanations that data gathered in this study would be analyzed so that individuals could not be identified, only those who consented would be analyzed, and no

Table 1. Fidelity checklist

1	If an error is made partway through the test in the MMSE subtraction task, subsequently tendered accurate responses are not regarded as correct answers.
2	In the MMSE comprehension task (three-stage command), the tester must issue each instruction separately rather than all at once, and then issue the next instruction every time the subject follows the previous instruction.
3	To score a point in the MMSE picture-copying task, the two pentagons must intersect at two points, and the overlapping parts of the pentagons must be shaped like a rhombus.
4	In the MOCA-J clock-drawing task, the subject does not necessarily need to write the numbers as long as the clock hands point to 11:10.
5	Responses resulting from successful recall prompted by a clue are not included in the scoring in the MOCA-J delayed recall task.
6	In the WMS-R logical memory task, the subjects can narrate the story in words that are easy for them to remember and they do not necessarily have to recall the stories verbatim.
7	In the Rey–Osterrieth Complex Figure Test, the tester does not tell subjects that they will be asked at a later phase to draw the image they have copied in the first stage of the examination.
8	In the ADAS word recall task, the subject is asked to recollect the ten words after reading them in silence.
9	In the ADAS word recall task, the subject's score is the mean number of words not recalled after three trials.
10	In the Letter Fluency Test, the subject must say as many words as possible beginning with a given letter; proper nouns such as people's names are permitted, but adjectives are not.
11	In the WAIS Digit Symbol Substitution Test, subjects match digits and symbols; if the subjects commit an error, the tester must inform the subjects of the mistake and measure the time it takes to produce the correct answer.
12	In the Trail Making Test, the subject connects the points with a line from start to finish as quickly as possible and must complete the task without lifting the pencil from the paper.
13	In assessing the Trial Making Test, the time taken to complete the test is measured, and even if the subject makes an error part-way through the task, the tester must continue measuring the time until the test has been completed.
14	In the WAIS Digit Span Test, if one of the digits in the same sequence is incorrect, the test ends at this point without moving onto the next sequence.

disadvantages would arise because of consenting or not consenting to participate in the study. The informed consent of subjects was then obtained. This study was conducted with the approval of the Institutional Review Board at the Tottori University Faculty of Medicine (No. 19A024). The study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

RESULTS

The questionnaire disseminated via postal mail by the researcher six months after the training sessions yielded responses from 14 subjects, signifying a response rate of 70%. Therefore, these 14 individuals were the subjects of the final analysis. The average age of the 14 subjects was 44.1 (±10.7), and their average years of experience in neuropsychological testing was 6.5 (±7.7). By occupational category, two of the subjects were physicians, 10 were psychologists, and two were research assistants.

The differences found in the scores of each test before, immediately after, and six months after the training program are shown in Table 2. Of these, the main effect of time was significant [F (1, 13) = 28.77, $P < 0.001$] for the "fidelity" score. The effect size was large at $\eta^2 = 0.69$. A simple main effect test using the Bonferroni method revealed significant differences between the pre-training and post-training values and between the pre-training and six-month point values. However, no significant difference was found between the post-training and six-month point values.

Significant differences between the three time points were not observed in the scores for "interest in clinical geriatrics" [F (1, 13) = 0.01, n.s.], "understanding of cognitive functions" [F (1, 13) = 0.01, n.s.], "understanding of neuropsychological tests" [F (1, 13) = 0.13, n.s.], "smooth implementation of one test" [F (1, 13) = 0.09, n.s.], "non-invasive implementation of tests" [F (1, 13) = 0.09, n.s.], and "smooth implementation of multiple tests" [F (1, 13) = 0.01, n.s.].

No significant correlations were observed between fidelity and each self-efficacy scale (Table 3).

DISCUSSION

This study aimed to develop and to examine the usefulness of a training program on neuropsychological tests. The training program purposed to promote

Table 2. Means and standard deviations of the measures

	Before	Immediately After	Six months after	Statistics (F)
Fidelity	8.14 (0.91)	12.36 (0.29)	12.36 (0.63)	28.77***
Interest in clinical geriatrics	3.64 (0.63)	3.57 (0.65)	3.64 (0.63)	0.01
Understanding of cognitive functions	2.79 (0.23)	3.21 (0.16)	2.79 (0.24)	0.01
Understanding of neuropsychological tests	2.86 (023)	3.21 (0.16)	2.79 (0.24)	0.13
Smooth implementation of one test	3.14 (0.28)	3.14 (0.28)	3.07 (0.32)	0.09
Non-invasive implementation of tests	2.86 (0.25)	3.14 (0.14)	2.79 (0.28)	0.09
Smooth implementation of multiple tests	2.57 (0.29)	2.93 (0.17)	2.67 (0.33)	0.01

Standard deviations are in parentheses.
***$P < 0.001$

Table 3. Spearman rank correlation between fidelity and self-efficacy

	Interest in clinical geriatrics	Understanding of cognitive functions	Understanding of neuropsychological tests	Smooth implementation of one test	Non-invasive implementation of tests	Smooth implementation of multiple tests
Fidelity	–0.21	0.22	0.35	0.14	0.13	0.33

the understanding of cognitive functions and communication skills required for testers to perform the neuropsychological tests accurately and with sensitivity. For the primary evaluation criteria, the fidelity to neuropsychological tests, the main effect of time was significant. Fidelity scores were significantly higher after training and at the six-month time point than at the pre-training time point. Further, no significant difference was observed in the fidelity scores recorded immediately after the training and when six months had elapsed from the completion of the training sessions. This outcome indicates that the fidelity of the subjects to neuropsychological tests increased as a result of the training program, and that this improvement was maintained through the six-month period following the program. Moreover, the large effect size suggests that the training program may be effective in facilitating the mastery of neuropsychological tests in testers.

Since neuropsychological tests focus on different cognitive functions such as memory, attentional functions, and executive function, the test structures are often complex. These results highlight the possibility that the mastery of neuropsychological tests may be promoted through the inculcation of prior understanding in testers with regard to the cognitive functions that are subject to examination by particular neuropsychological tests. However, various forms of physiological decline experienced by seniors impact the results of neuropsychological tests and in many cases, the test results that are obtained underestimate the actual abilities of the subjects.[12] Further, neuropsychological tests are often administered to subjects who are suffering from dementia. Subjects in the early stages of dementia are more vulnerable to damage to their self-esteem because they are no longer able to perform functions they could previously accomplish. In addition, the early stages of dementia are often accompanied by depression.[19, 20] Therefore, when conducting neuropsychological tests, testers must consider the physiological decline experienced by seniors and at the same time, they must employ superior communication skills to adequately identify the cognitive functions of the elderly while avoiding the elicitation of a feeling of discomfort in them. In this training program, content pertaining to communication was narrowed down to five relevant skills that would prevent subjects of testing from feeling uncomfortable and that would account for the physiological decline expected due to aging. When participants are required to learn a large number of skills, and the difficulty of the training is high, motivation for learning is easily lost. The communication skills presented in this training program were considered to be at an appropriate level of ability for the subjects.

The participants' self-efficacy about the administering of neuropsychological tests was a secondary evaluation criterion. Time did not appear as a main effect for any of the statements recorded in this respect. In other words, no significant differences were found in self-efficacy scores before, immediately after, and six months after the training. Self-efficacy expresses the level of confidence with which a person can perform an action well and it has been found to be the factor most closely associated with behavioral change.[21] The scores on each self-efficacy scales showed high values at the three points before, immediately after, and six months after the training. In other words, it can be thought that, due to the ceiling effect, no significant differences in scores were observed among the three time points. In addition, no significant correlations were observed between fidelity and the scores on each of the self-efficacy scales. This suggests that self-efficacy in relation to neuropsychological tests is not necessarily essential for improving fidelity to neuropsychological tests.

Finally, certain limitations of the study must be acknowledged and challenges for the future should be outlined. The study did not include a group that only received training in neuropsychological tests without training in cognitive functions and communication. Accordingly, it cannot be concluded that a training program that includes components focused on cognitive functions and communication is effective in helping testers master the skills required to administer neuropsychological tests accurately and with due sensitivity. In the future, researchers should compare a group of subjects who undergo training on neuropsychological tests that includes training on cognitive functions and communication against the results obtained from a group for which these topics are not included to compare the level of mastery of neuropsychological tests through measures such as fidelity. Moreover, some testers included in the study had already accrued many years of neuropsychological testing experience. It is reasonable to assume that these individuals would already have accumulated sufficient understanding about non-invasive communication when assessing cognitive functions and conducting tests. To nurture testers who can smoothly implement a larger number of neuropsychological tests, it will be necessary to develop such training programs for students and testers with fewer years of neurological testing experience. It is this group of participants that will enable researchers to comprehensively verify the effects training programs aimed to enhance the understanding of cognitive functions and communication skills necessary for the administering of neuropsychological tests. This study used a fidelity check to measure the level of mastery of neuropsychological tests. However, to conduct a detailed examination of neuropsychological test mastery levels in the future, in addition to fidelity, it is necessary to examine the rates of concordance in test results with experienced testers as well as accuracy when actually implementing tests.

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