■ORIGINAL ARTICLE

Differences between older and younger drivers in a Japanese road sign recognition task

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Abstract: Recent years, cases in which an occupational therapist is involved in the evaluation of patients' driving ability are rapidly increasing in Japan. One of the neuropsychological tests which are predictive of driving ability is a road sign recognition task (RSR). However, no RSR available in Japan has yet been reported. Hence, in this study, we developed a Japanese version of road sign recognition task (J-RSR). A total of 44 younger drivers and 43 older drivers living in the community took part in the study. We compared the number of correct answers and the total time taken to complete the task between the two groups. Results showed that there was no statistically significant differences for the number of correct answer ($p = 0.43$), while older drivers took significantly much longer than younger drivers to complete the task ($p < 0.000001$). Qualitative analysis on incorrect answer for each question revealed that older drivers chose the same incorrect road sign answer while younger drivers chose incorrect answer evenly among options. These results suggest that J-RSR is predictive of knowledge of road sign, non-verbal reasoning ability, mental speed, and might reflects subjects' driving experience.

Keywords: driving, assessment, road sign recognition task

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Introduction

It is estimated that about 65% of the Japanese population currently has an ordinary motor vehicle license (i.e., driver's license) [1]. Indeed, for many, cars are an indispensable means of transport in daily life. If individuals are deprived of the use of their cars due to disability, their quality of life can significantly decrease [2]. Therefore, it is very important to evaluate disabled subjects' driving ability while they are hospitalized. Cases in which an occupational therapist is involved in the evaluation of patients' driving ability are rapidly increasing at medical institutions that deal with stroke and dementia patients in Japan.

One aspect of driving ability evaluations carried out at medical institutions is the neuropsychological evaluation. This evaluation assesses whether an individual has the necessary cognitive functions required to drive a car, and often includes a visual search task [3−5], reaction time task [6−8], visuo-spatial recognition task [9−11], useful field of view test [12, 13], and intelligence test [14−16]. However, these tests have a shortcoming in that they do not use actual driving scenes in their assessments. This, in turn, leads to clinical problems such as lack of agreement between patients and occupational therapists on whether the test results reflect patients' actual driving ability.

One test, called the Stroke Driving Screening Assessment (SDSA), has been developed specifically for the evaluation of driving ability [17]. The SDSA is widely used for predicting the results of on-road evaluations [18−21]. The SDSA comprises four tasks: dot cancellation, compass, square matrix, and the road sign

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recognition test (RSR). Dot cancellation is used as an indicator of visual attention function, while the square matrix and compass are used as indicators of the ability to identify orientation and the RSR as an indicator of knowledge of road signs. The result of each sub-test correlates with the result of an on-road evaluation [20−23].

Among these sub-tests, we are most interested in the RSR, which is more closely related to actual driving. The test requires the patient to identify the road sign appropriate for a given road situation. Passing this test requires both knowledge of road signs and non-verbal reasoning ability [24−25]. However, in all cases reported to date, drawings of road signs and road situations have been used instead of photographs. In addition, because road signs and traffic regulations differ by country, tests developed in a foreign country cannot be used in Japan. We have therefore developed the Japanese version of the RSR (J-RSR) using photographs to present the road situations. In this study, we report the results of an analysis of the characteristics of older and younger driver's license holders.

Methods

Participants

A total of 44 younger driver's license holders (17 male drivers and 27 female drivers; age: 22.0 ± 2.9 years old) and 43 older driver's license holders (22 male drivers and 21 female drivers; age: 68.0 ± 6.0 years old) living in the local community took part in the study. The average score of the Mini-Mental State Examination (MMSE) of the older driver's license holders was 28.7 ± 1.4. Among younger driver's license holders, 5 obtained their licenses less than a year ago, 13 obtained them between one and two years ago, 12 obtained them between two and three years ago, 11 obtained them between three and four years ago, and 3 obtained them more than three years ago. In terms of driving frequency, 2 were driving daily, 4 were driving once every 2 or 3 days, 6 were driving once a week, 15 were driving a few times a year, and 17 hardly drove. Among the older driver's license holders, 32 had obtained their licenses more than forty years ago, 2 each had obtained them between 10 and 20 years ago and between 20 and 30 years ago, and 7 had obtained them between 30 and 40 years ago. All participants received an explanation of the study verbally and in writing and gave consent. The study was carried out upon obtaining approval from the Medical Research Ethics Committee of Shinshu University (approval number: 2081)

Tasks and procedures

The participants took the J-RSR and the Trail Making Test (TMT) using a touch-screen notebook computer (CF-C1B 12.1"; Panasonic Corporation, Japan; hereafter "PC").

The J-RSR is a task in which the participant chooses a road sign appropriate for the road situation. In the photographs presenting the road situations, the road signs are obscured via photo editing. The participant is asked to evaluate the road situation and choose the most appropriate road sign (Fig. 1). Each question is worth one point and there are ten questions in total. The PC records the number of correct answers, the road signs chosen, whether these signs are correct or not, and the total time taken to answer the questions.

As for the TMT, a new version was developed wherein the arranged stimulus from the paper version is placed onto the PC screen at the same ratio. The major differences between the paper and PC versions of the TMT are a) when the correct target is touched, the PC produces a target sound indicating a correct answer, and when an incorrect target is touched, it produces a sound indicating an incorrect answer, and b) all targets remain on the screen even after the correct target is touched. Preceding studies have found that part B of the TMT (TMT-B) requires more time to complete and produces more incorrect answers than does part A (TMT-A) [26]. The PC records the time taken to complete the task and the number of correct and incorrect answers. When the time taken to complete the task exceeded five minutes, it was treated as a missing value.

The program for the tasks was constructed by Nishizawa Electric Meters Manufacturing Co., Ltd.

Fig. 1. An example of the Road sign recognition test. The participant chooses a road sign appropriate for the road situation. For this question, Option 1 is the correct road sign.

Analysis

The result of each task was compared between the older and younger groups. In the case of the J-RSR, the comparisons were made between the number of correct answers, the time taken to complete the task, and the correct answer rate for each question. In the case of the TMT, comparisons were carried out in terms of the time taken to complete the task and the number of incorrect answers. Unpaired t-tests were used for all statistical analyses, and the significance level was set at 5% for all analyses.

Results

There were no statistically significant differences between the two groups in the number of correct answers on the J-RSR (t (85) = −0.80, p = 0.43; older group: 8.2 ± 1.7 [range: 4−10]; younger group: 8.5 ± 1.2 [range: 5−10]; Fig. 2-a). On the other hand, the older group took significantly longer to answer the questions (t (85) = 7.20, $p < 0.000001$; older group: 246.0 ± 113.8 seconds; younger group: 114.7 ± 40.8 seconds; Fig. 2-b). As for the correct answer rate for each question, in the case of Question 1, 46.5% of the older group answered correctly, while 68.2% of the younger group answered correctly; this difference in favor of the younger group was significant (Z = −2.05, $p < 0.05$). There were no significant differences between the two groups for any of the other questions (Table 1). There was an interesting finding for Question 1: while the correct answer is option 1, many of those from the older group who answered incorrectly chose option 3, whereas those who answered incorrectly among the younger group had evenly distributed answers among options 2−4 (Fig. 3).

In the case of the TMT-B, one participant from the older group took more than five minutes to complete the task; this participant's answer was thus treated as a missing value. The older group took significantly longer to complete the tasks for both the TMT-A and the TMT-B (TMT-A: t (85) = 7.96, $p < 0.000001$; older group: 73.8 ± 19.5 seconds; younger group: 48.0 ± 9.0 seconds; TMT-B: t (84) = 9.70, $p < 0.000001$; older group: 133.3 ± 45.6 seconds; younger group: 62.2 ± 16.4 seconds; Fig. 4-a). There was no significant difference between the two groups in terms of the number of incorrect answers on the TMT-A (t (85) = 1.33, $p = 0.19$; older group: 0.6 ± 2.6 times; younger group: 0.0 ± 0.3 times). However, on the TMT-B, the number of incorrect answers was significantly higher for the older group (t (84) = 4.53, $p < 0.00001$; older group: 2.6 ± 3.4 times; younger group: 0.3 ± 0.5 times; Fig. 4-b).

Table 1. Percentages (%) of correct answer between the two groups. No statistically differences were found between the two groups other than Question 1.

	Older (N = 43)	Younger (N = 44)	Statistical value (p value)
Q.1	46.5	68.2	Z = −2.05 ($p < 0.05$)
Q.2	90.7	97.7	n.s.
Q.3	69.8	61.4	n.s.
Q.4	90.7	81.8	n.s.
Q.5	95.3	97.7	n.s.
Q.6	74.4	77.3	n.s.
Q.7	90.7	81.8	n.s.
Q.8	93.0	97.7	n.s.
Q.9	83.7	93.2	n.s.
Q.1O	86.0	88.6	n.s.

n.s.; not significance

Discussion

As far as we know, there have been reports on four kinds of tests using road signs. Carr et al. [27] developed the traffic sign naming test and reported that the test can differentiate between patients with dementia of

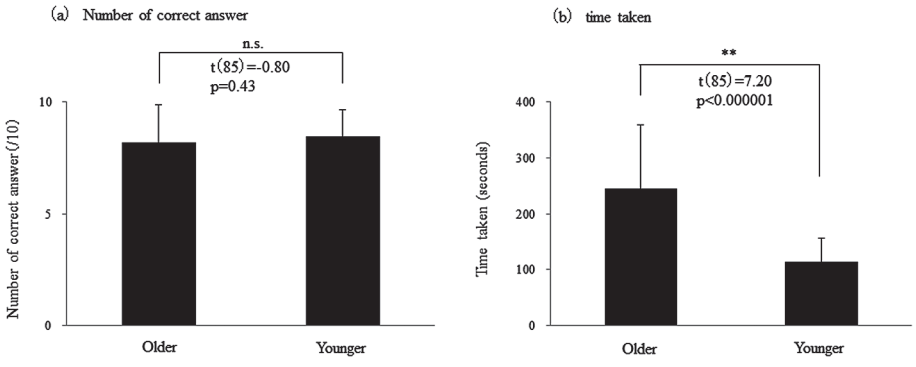

Fig. 2. Results of the road sign recognition test.
For the number of correct answer, no statistically significant differences were found (a), while the older group took significantly longer to answer the questions (b). n.s.; not significance, **; $p < 0.000001$

	1	2	3	4
Older (N=43)	20	5	15	3
Younger (N=44)	30	4	4	6

Fig. 3. Distribution of participants' response in the Question 1 (The correct answer is option 1). Many of those from the older group who answered incorrectly chose option 3, whereas those who answered incorrectly among the younger group had evenly distributed answers among options 2−4.

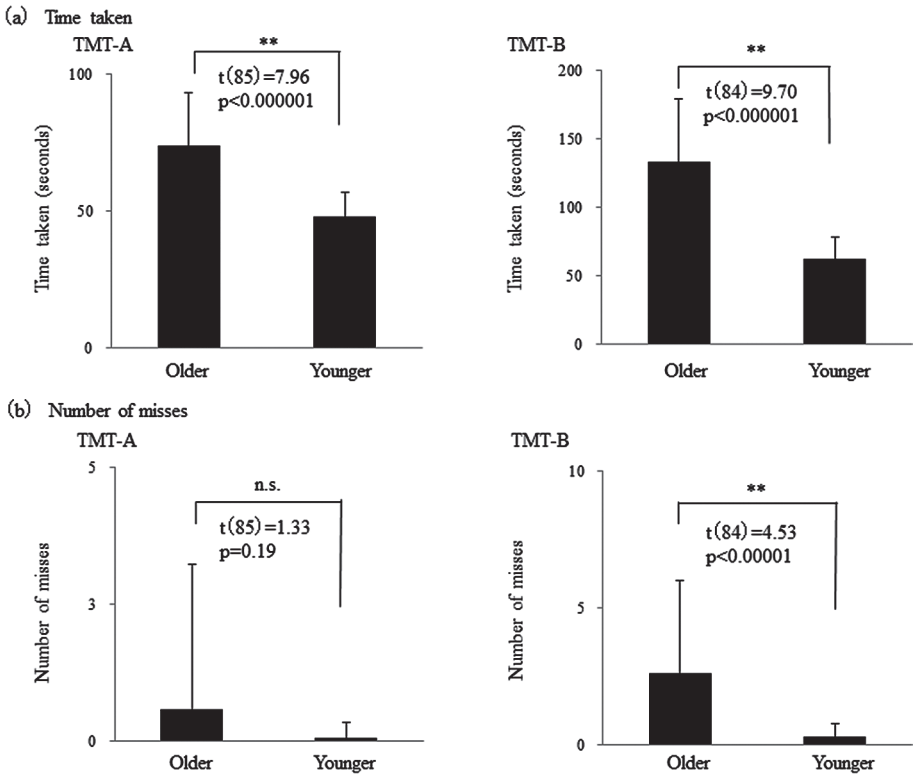

Fig. 4. Results of the TMT-A and the TMT-B.
The older group took significantly longer to complete the tasks for both the TMT-A and the TMT-B (a). While there was no differences between the groups for the number of misses on the TMT-A, older group showed significantly higher number fo incorrect answeres on the TMT-B. n.s.; not significance, **; $p < 0.000001$

the Alzheimer's type (AD) and neurologically healthy elderly people (healthy). This task uses photographs of actual road signs and requires participants to identify their meaning. Since this test only addresses knowledge of road signs, it is very different from the J-RSR, which requires the subject to comprehend the road situation from a photograph and to choose a road sign appropriate for that situation. Uc et al. [28] examined the Landmark and Traffic Sign Identification Task and reported that it can differentiate AD from healthy subjects. The test measures how many landmarks and signs that appear in a driving video can be identified. While it does require visual searching ability, it does not require knowledge of road signs, which makes it different from the J-RSR. Brown et al. [29] examined the driving scenes test, wherein the subject is consecutively shown two color drawings of a road situation, separated by a brief interval, and is then required to point out the differences between the two drawings. This test requires visual memory capacity, not knowledge of road signs, which means that completing it requires different abilities than those required for completing the J-RSR. While the RSR in the SDSA [18, 21, 30, 31] is very similar to the J-RSR, as pointed out in the introduction, it differs from the J-RSR in that it uses drawings, not photographs; furthermore, it does not present Japanese road situations. These findings suggest the novelty of the J-RSR.

It has been reported that the RSR is predictive of the results of on-road evaluations (Lincoln et al., 1992, [5, 20, 21, 31−33]. The RSR is a complex task that requires good visual cognition, mental speed, working memory, executive function, and non-verbal reasoning simultaneously [21, 23−25, 34]. Each cognitive faculty is necessary to drive a car. Since the major difference between the J-RSR and RSR is the fact that the former uses photographs of road situations in Japan while the latter does not, they can be considered to assess the same cognitive faculties. Our analysis of the results showed that while there is no difference between older and younger driver's license holders in the number of correct answers, the younger group was faster at answering the questions. This suggests that while there is no difference between the two groups in terms of the ability to evaluate a driving situation or choose an appropriate road sign, there is a difference in mental speed to reach the conclusion. In other words, the result highlights that, among all cognitive faculties necessary to complete the task, the primary difference between the groups was in mental speed. This assumption is supported by the fact that the younger group was significantly faster in the TMT. However, analysis of the correct answer rate for each question indicates that the results cannot be explained by mental speed alone (Fig. 3). In Question 1, the subject is required to comprehend a situation in which "one cannot go straight ahead" and to choose the road sign that reflects that situation. Option 1 (the correct answer) is a "no vehicle entry" sign, option 2 is a "maximum speed 50km/h" sign, option 3 is a "stop" sign, and option 4 is a "no vehicle entry except bicycles and motorcycles" sign. Many of the older participants who chose the incorrect option chose option 3, while younger participants' incorrect answers were evenly distributed over options 2−4. The fact that the answers were not distributed evenly suggests that there are trends present in comprehending the situation. It has been inferred that the difference in the distribution of answers is related not to mental speed but to differences in the ability to comprehend situations based on driving experience [35, 36]. Preceding studies on the RSR including older people have reported that in a 12-point test, the older drivers' median score was 7 (interquartile range 6−10; [20]) and the mean was 8.2 ± 2.4 (range: 2−12; [30]). In comparison to these reports, the results of the present study suggest a higher correct answer rate. In order to examine the effectiveness of the J-RSR as an evaluation of driving ability, future investigations among stroke and dementia patients must be performed. In relation to the errors that we identified that are caused by cognitive factors other than mental speed, tests should be carried out among patients with brain damage who show symptoms of reduced cognitive function.

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