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ORIGINAL ARTICLE

Cued and Un-Cued Semantic Category Fluency in Older Adults with Mild Cognitive Impairment

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Background and Purpose Patients with switching deficits reportedly benefit more from categorical cueing for semantic category fluency than do patients with clustering deficits. We explored the contribution of language ability and executive control on the performance of semantic category fluency in older adults with mild cognitive impairment (MCI) by examining the effects of categorical cueing on the task.

Methods Order adults with MCI (n=10) and normal controls (n=25) were compared on two versions of a semantic fluency task: a standard, un-cued version (SF) and a version in which subjects were cued (C-SF) with 4 subordinated categories. The scores and error types of SF and C-SF tasks were analyzed between two groups. Also, the correlation among the SF task, the C-SF task, and the confrontation naming task were examined.

Results The performance of the sematic fluency task improved when categorical cues were included in both groups. However, the normal group showed significantly more improvement than the MCI group. Self-repetition errors in the SF task and categorical errors in the C-SF task occurred most frequently. The normal group showed significantly more errors than the MCI group in the C-SF task. There was a positive correlation among the SF task, the C-SF task, and the confrontation naming task.

Conclusions The results of the present study suggested that the MCI group has more difficulty in the semantic memory store rather than in the use of retrieval strategies. A combination of standard and cued semantic fluency tasks may help to confirm the underlying deficit of semantic fluency impairment.

Key Words semantic category fluency, cued semantic category fluency, mild cognitive impairment.

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INTRODUCTION

Recently, the interest in the prodromal stage of dementia that includes a transitional cognitive stage between the normal aging and the early stage of dementia, i.e., 'mild cognitive impairment (MCI)' has been increasing. MCI refers to the stage between the normal aging and dementia in the cognition continuum.[1] Reportedly, 10−15% cases of MCI progress to diagnosed dementia each year, or about 50% of them progress to dementia in 3 years;[2] another study showed that in a few years, 55−72% cases with MCI progressed to dementia, in particular, Alzheimer's disease with the annual conversion rate of about 12%.[3] As mentioned above, since MCI is highly likely to progress to dementia, appropriate measures at this stage are very important to suppress or delay the progression to dementia. Therefore, accurate diagnosis of MCI before it progresses to clinically apparent dementia can be a critical strategy for early detection of dementia and intervention.[4]

All patients with dementia exhibit semantic and lexical system deficits. Among several types of tests to examine the characteristics of semantic-lexical system in dementia, the category fluency task is convenient, useful, and widely used in the clinical setting. It examines the ability to generate words of the category within a limited time and is also known as verbal fluency test, generative naming test, and controlled oral word as-

sociation test. The test is classified into the semantic category task, which requires generation of words of a specific semantic category; and the phonemic category task, which requires generation of words beginning with specific phoneme or letter.[5]

Semantic category task is preferable to phonemic category to evaluate the semantic-lexical system deficit in patients with dementia, since it involves word retrieval on the basis of the semantic relationship, as compared to the phonemic category task that involves retrieval of morphologically similar words regardless of their semantic relationship. Performance of the semantic category task is reported as significantly lower than the phonemic category task in dementia of Alzheimer's type.[6]

The semantic category fluency task enables the evaluation of semantic memories, quantity of words stored in the lexical repository, and the ability to retrieve them. The retrieval ability includes the cognitive strategy for retrieval of greater number of words within a given time. Therefore, if the small quantity of words is stored with specific meaning, and if the language output and the ability to use cognitive strategy to retrieve words efficiently within the given time has deficits, the task performance is negatively impacted. Therefore, several researchers use the concepts of clustering and switching.[7] Clustering ability refers to the capacity to recollect and retrieve the words within the same category among sub-categories of semantic category in sequential order; and switching ability refers to the capacity to change the category to another sub-category when the person cannot retrieve any more words through recollection within one category. Thus, the former is associated with the quantity of words stored in repository in applicable semantic category and ability to retrieve them, while the latter is associated with executive function of strategic exploration and cognitive flexibility. Also, it is described in connection with lesions of the brain, for e.g., the temporal lobe dysfunction causes problems in clustering ability and the frontal lobe dysfunction causes problems in switching ability.[7,8]

Several studies conducted the semantic category fluency task by suggesting the cues of sub-category in order to separately investigate the clustering ability and the switching ability.[9-11] In the cued sub-category task, the investigator provides information of sub-category in advance, when conducting the semantic category fluency task. For example, the method requests retrieval of as many animal names as possible within 60 seconds; the total 60 seconds are divided into 4 segment units of 15 seconds, and at the start of each segment, the subcategories such as 'pets growing at private home', 'livestock being bred at farms', 'animals living in jungle' and 'animals living in water' are suggested. One such study reported that the cued task performance was substantially improved in Huntington's disease and in Parkinson's disease, while it was not improved in Alzheimer's disease;[11] in addition, a study showed that provision of cue was significantly beneficial in the frontal lobe dysfunction, as compared to the temporal lobe dysfunction.[9] Based on these results, the investigators suggested that the problem of cognitive processing i.e., switching should be suspected when the task performance improves after cuing; whereas it is reasonable to suspect problems of language representation and language processing i.e., clustering, when the cued task performance shows little change.

Most researchers agree that the semantic category fluency performance declines with the progression of dementia.[11,12] Randolph et al.[11] reported that patients with Alzheimer's disease showed no significant differences in the performance depending on whether cued or un-cued due degeneration of the semantic memory repository. Thus, in the dementia of Alzheimer's type, the quantity of stored words is reduced with progressive degeneration of the semantic memory repository, thus, the performance of semantic category fluency inevitably declines regardless of being cued or not. However, while lower semantic category fluency was reported for cases with MCI, as compared to the normal elderly group;[13] another study reported that semantic category fluency was not lower.[14] Moreover, few studies identify when the performance deficits are related to the clustering, or the switching in respect to cueing.

Therefore, in this study, we verified whether the group with MCI showed deficits in performance of semantic category fluency, as compared to the normal group by comparing the difference in performance depending on cueing/un-cueing. Any differences in performance observed between the un-cued semantic category fluency task and the cued semantic category fluency task in the group with MCI, indicates the switching deficits but otherwise, it may indicate the clustering deficits as in dementia of Alzheimer's type. In addition, comparison of error types during the task performances between two groups verified whether the difficulties faced by the MCI group in performing the semantic fluency task were of different quality, as compared to the normal group. Finally, the association between the un-cued semantic category fluency task performance, the cued semantic category fluency task performance, and the confrontation naming task performance which is frequently used in the clinical setting together with the category fluency task, were examined through the correlation analysis.

METHODS

Subjects

A total of 35 subjects ≥65 years old consisted of 25 non-demented elderly people and 10 patients with MCI had par-

ticipated in this study. The subjects were users of the services provided by the Elderly Welfare Centers in Gyeongbuk region in Korea, and the patients with MCI among them were participants in the cognitive function improvement programs of the applicable Welfare Centers after diagnosis with MCI. Pretest interviews were conducted for participants' ages, years of education received and health conditions. The participants using Korean as native language, having no problems in vision and hearing for daily living activities, and with no medical history of neurologic and mental disease were primarily selected. Illiterate subjects were excluded. Subsequently, the secondary selection was with the following criteria. First, those with the result of Korean version of the Mini-Mental State Examination (K-MMSE)[15] of ≥1.5 standard deviation (SD) (score ≥16%ile) were included, secondly those with medication for hypertension or diabetes mellitus[16] were excluded, and thirdly, those with depression of ≥moderate severity from the Geriatric Depression Scale[17] were excluded.

Among the secondarily selected subjects, those with complaints of memory deterioration by the subject or the caregiver, and with the score of delayed recall ≤16% in the memory domain of Neuropsychological Screening Seoul Neuropsychological Screening Battery[18] were classified as the MCI group and the rest of participants were classified as the normal group. Diagnosis of MCI was confirmed according to diagnosis criteria presented by Petersen[1] and Winblad et al.[19] Prior to the start of the study, all participants provided consent after they were sufficiently informed in advance about the purpose of the study, content of investigation, the required time, and voluntary nature of participation or discontinuation of participation.

Study tasks

As the experimental task of this study, 'Animal Naming Test' was selected based on a study of Kang et al.[5] The un-cued semantic category fluency task is the same as generally used semantic category fluency task, which asks the subjects to generate as many as possible animal names for 60 seconds. For the cued semantic category fluency task, 60 seconds were divided into 4 segment units of 15 seconds. By each segment, the subordinate categories were presented and the subjects were required to generate as many as possible animal names applicable to each category for 15 seconds. The subordinate categories were defined as 'insects', 'birds', 'fishes', and 'general animals' by referring to the precedent studies on the semantic category.[20,21] As soon as starting each segment, the examiner presented the applicable title of the subordinate category by writing it on the screen of laptop computer in letters. The confrontation naming test for correlation analysis was conducted using the Korean Version of Boston Naming Test (K-BNT).[22]

Study procedures

In this study, the test was conducted serially in a quiet and separate room. 'Fruits' category was explained as an example and when complete subject understanding was confirmed, the test was begun. The test was done in a sequence of the un-cued semantic category fluency task, the confrontation naming task (K-BNT), and the cued semantic category fluency task. When the cued semantic category fluency task was performed first, it was likely to affect the un-cued semantic category fluency task by providing the clue for the subordinate categories; therefore, the un-cued semantic category fluency task was implemented first. The examiner told the subject "When I say 'start', please tell me the animal names as many as you know. Do you understand?" and then, instructed by saying "Start!". When 60 seconds had passed, the examiner said "Stop". K-BNT was conducted as described in the test manual. On completion of the K-BNT and after call to attention, the cued semantic category fluency task was conducted. The task was conducted in the same method as previously used, but the examiner explained to the subjects that the hint would be provided on the laptop computer and they were to provide the animal name corresponding to the hint. The time was measured with a stopwatch, and after 15 seconds, a cue was provided immediately for the next subordinate category. The clueing was done in the order of 'insects', 'birds', 'fishes' and 'general animals', which was done in the same way for all the subjects. The examiner simultaneously recorded and documented all responses of the subject on the recorder.

Data processing

The examiner recorded the number of words generated by the subjects and scored them in the tasks of the un-cued semantic category fluency and the cued semantic category fluency. When the subject repeated a same word, it was counted 1 time only, and the repetitive response was classified as wrong response. For error analysis, all the responses of the subjects were documented for the items of wrong responses. The error types of the subjects were classified into three types i.e., repetition error, category error and unrelated error. The repetition error refers to re-generation of a word already generated. The category error refers to generation of words belonging to another sub-categories; for example, when the subject generated 'cutlass fish, mackerel, ray-finned fishes and pig' for 'Fishes' category, 'pig' was applied to the category error. The unrelated error refers to generation of word that is unrelated to the corresponding category semantically; for example, the words 'sparrow, magpie, crow and apple' for 'Birds' category,

'apple' was applied to the unrelated error. Scoring the results of K-BNT was done as described in the test manual.

Statistical analysis

For comparison of task executive ability according to the inter-group (2) cueing (2), the 1 inter-subjects − 1 intra-subject mixed design repeated measures ANOVA was conducted. The 1 inter-subjects − 2 intra-subject mixed design repeated measures ANOVA was conducted to compare the frequency by the error type (3) according to the inter-group (2) cueing (2). In addition, Pearson correlation analyses between each task were conducted without dividing the groups for correlation analyses between K-BNT, Un-Cued Semantic Category Fluency, and Cued Semantic Category Fluency task.

RESULTS

An Independent Samples *t* test was conducted prior to analysis of results in order to compare differences in the ages, years of education, K-MMSE scores, and scores of delayed recall between the group with MCI and the normal control group. The results indicated no statistically significant differences in all variables (p>0.05) except the scores of delayed recall (p<0.001) (Table 1).

Comparison of cued and un-cued semantic category fluency between groups

From the task for un-cued semantic category fluency, the normal group scored 11.08 points (SD; 3.44) in average; whereas, the group with MCI scored 8.80 points (SD; 3.70). From the task for cued semantic category fluency, the normal group scored 17.28 points (SD; 3.44) in average, whereas the group with MCI scored 11.90 points (SD; 3.70). The statistical analyses showed that the main effect between the groups ($F_{(1,33)}$= 15.17, p<0.05) and the main effect depending on cueing ($F_{(1,33)}$= 38.99, p<0.05) were significant (Table 2). Thus, regardless of cueing, the group with MCI showed significant deterioration in performance of the semantic category fluency, as compared to the normal group. Regardless of groups, the cued semantic category fluency task showed significantly improved performance, as compared to the un-cued semantic category fluency. Also, as the interaction effects of the groups and the cueing were presented as significant ($F_{(1,33)}$=4.33, p<0.05) (Table 2), an Independent Samples *t* test between two groups was conducted for each tasks to identify further details on the above outcomes. The results indicated no significant differences between the two groups in the task for un-cued semantic category fluency (p>0.05), whereas in the task for cued semantic category fluency, the performance of the group with MCI was significantly deteriorated, as compared to the performance of the normal group (p<0.001).

Comparison of error type frequency of cued and un-cued semantic category fluency between two groups

In average, the normal group showed 0.40 times (SD; 0.20) of repetition error and each 0.4 times (SD; 0.20) of category error and unrelated error, respectively in the un-cued semantic

Table 1. Characteristics of participants

Group	*n*	Gender		Mean (SD)			
		Male	Female	Age (yr)	Education (yr)	K-MMSE	Delayed recall (SNSB)
Normal	25	1	24	74.84 (2.54)	4.92 (1.93)	25.84 (1.62)	5.04 (1.50)
MCI	10	0	10	74.30 (3.02)	3.90 (1.91)	24.90 (0.72)	1.7 (0.82)
p-value				0.59	0.167	0.138	0.000

K-MMSE: Korean version of the Mini-Mental State Examination, MCI: mild cognitive impairment, SD: standard deviation, SNSB: Seoul Neuropsychological Screening Battery.

Table 2. Results of repeated ANOVA for cued and un-cued semantic category fluency between two groups

Sources	SS	df	MS	F	*p*
Between group					
Group	209.56	1	209.56	15.17	0.000
Error	455.93	33	13.82		
Within group					
Cueing	308.89	1.00	308.89	38.99	0.000
Group×cueing	34.32	1.00	34.32	4.33	0.035
Error	261.45	33.00	7.92		

df: degrees of freedom, MS: mean square, SS: sum of squares.

Table 3. Results of repeated ANOVA for error types of cued and un-cued semantic category fluency between two groups

Sources	SS	df	MS	F	*p*
Between group					
Group	0.94	1	0.94	1.30	0.264
Error	23.14	33	0.72		
Within group					
Cueing	0.07	1.00	0.07	0.41	0.526
Group×cueing	0.83	1.00	0.83	5.00	0.033
Within group					
Error types	3.51	2	1.76	4.66	0.013
Group×error types	1.05	2	0.52	1.39	0.258
Error	24.17	64	0.38		
Within group					
Cueing×error types	9.17	2	4.58	8.31	0.001
Group×cueing×error types	0.82	2	0.41	0.74	0.482
Error	35.30	64	0.55		

df: degrees of freedom, MS: mean square, SS: sum of squares.

Table 4. Correlation between K-BNT, un-cued semantic fluency and cued semantic fluency

	K-BNT	SF	C-SF
K-BNT			
SF	0.387*		
C-SF	0.505†	0.382*	

*p-value<0.05, †p-value<0.01.
C-SF: cued semantic category fluency, K-BNT: Korean version of Boston Naming Test, SF: semantic category fluency.

category fluency task; while the group with MCI showed 0.60 times (SD; 1.26) of repetition error in average only. For the cued semantic category fluency task, the normal group showed 0.60 times (SD; 1.26) of repetition error in average only, while the group with MCI showed 0.30 times (SD; 94) of category error in average only.

The statistical analyses showed that the main effect between the groups ($F_{(1,33)}$=1.3, p>0.05) and the main effect depending on cued and un-cued ($F_{(1,33)}$=41, p>0.05) were not significant. However, the main effect depending on error types ($F_{(2,64)}$=4.66, p<0.05), the interaction effect between the cueing and the error types ($F_{(2,64)}$=8.31, p<0.01) and the interaction effect between the groups and the cueing ($F_{(1,33)}$=5.00, p<0.05) were significant. In addition, the interaction effect of the groups and the error types ($F_{(2,64)}$=1.39, p>0.05) as well as the interaction effect between three factors that were the groups, the cueing and the error types ($F_{(2,64)}$=0.74, p>0.05) were not significant (Table 3).

Bonferroni post-hoc test to investigate the main effect depending on the detailed error types revealed that repeated errors and the category error were significantly higher than unrelated errors (p<0.01). The paired t-test between two tasks in each error type for detailed analysis of interaction effect between the cueing and the error types, indicated that the repeated error was significantly higher in the un-cued semantic category fluency task than in the cued semantic category fluency task, while the category error was significantly higher in the cued semantic category fluency task than in the un-cued semantic category fluency task (p<0.05). Finally, the Independent Samples t-test for each task in order to investigate the interaction effect between the group and the cueing in details, showed no significant inter-group differences in the un-cued semantic category fluency task (p>0.05), but in the cued semantic category fluency task, the normal group showed significantly higher frequency of errors than the group with MCI (p<0.05).

Correlation between confrontation naming, un-cued semantic category fluency task and cued semantic category fluency task

The correlation coefficients of K-BNT and the un-cued semantic category fluency was 0.387, the correlation coefficients of K-BNT and the cued semantic category fluency was 0.505, and the correlation coefficients of the un-cued semantic category fluency and the cued semantic category fluency was 0.382. The correlations between all tasks were statistically significant (p<0.05) (Table 4).

DISCUSSION

This study was conducted to compare the performance of the un-cued category fluency task and the cued category fluency task in order to determine the semantic fluency depending on cueing for sub-category in the normal group and the

group with MCI. Regardless of cueing, the group with MCI showed significant deterioration in performance of the semantic category fluency, as compared to the normal group; and regardless of groups, the cued semantic category fluency task showed significantly improved performance, as compared to the un-cued semantic category fluency. However, since the interaction effects depending on the groups and the cueing were significant, a post-hoc test was conducted. The results indicated that the performance of the group with MCI was significantly deteriorated in the task for the cued semantic category fluency only. Analysis of the error types indicated that the repeated error and the category error were significantly higher in number, as compared to the unrelated error; and by the task, the repeated errors in the un-cued semantic category fluency and the category error in the cued semantic category fluency appeared significantly higher than the cued semantic category fluency and the un-cued semantic category fluency, respectively. Analysis of interaction effect depending on the group and the cueing indicated that the normal group had rather higher frequency of error in the cued semantic category fluency. In addition, all of the confrontation naming, the un-cued semantic category fluency and the cued semantic category fluency tasks showed significant correlations.

Importantly, the un-cued semantic category fluency showed no group wise differences; but in the cued semantic category fluency, performance of the group with MCI was significantly deteriorated, as compared to the normal group. As mentioned in the introduction, the reports on the semantic fluency in patients with MCI are conflicting. The two groups showed no significant differences in the un-cued semantic category fluency, corroborating the findings from a previous study[14] that showed if the tasks were conducted by using general method, the semantic category fluency performance of the group with MCI would not be inferior to the normal group.

Both groups had shown improved performance in the cued semantic category fluency task for which the cues for the sub-categories were provided; however, in the normal group, the level was prominently high, presenting significant differences between the two groups. Improved performance on cueing confirmed that the semantic category fluency task does not merely focus on the word retrieval ability but also requires the switching ability between the sub-categories, i.e., executive function. In addition, the result that it was more effective in the normal group implicates that the normal aging process is also associated with the substantial decline of executive function. On the other hand, the group with MCI did not benefit from cueing as much as the normal group. Such result suggests that the decline of semantic category fluency in the group with MCI could be due to clustering deficits rather than the switching deficits. Thus, the cued semantic category fluency task that requires lesser executive function i.e., the inter-categorical switching, has difficulties and is indicative that the decline of cued semantic category fluency in the group with MCI is induced by small quantity of language information stored or by the presence of deficits in the word retrieval itself, or by both, rather than the executive functional problem.

The results of error analysis indicated a significantly higher frequency of errors in the normal group than the group with MCI in the cued semantic category fluency task. The normal group showed the highest category error in the cued semantic category fluency task (Table 2), which was applicable to retrieved words belonging to another sub-categories. According to the lexical access model of Dell et al.,[23] retrieval of words involves the activation of not one target word alone but of several words connected to the lexical network simultaneously. Therefore, the speaker has to select only one target word successfully while suppressing other words than the target word. At this time, the word that has semantic association with the target word shows stronger activation intensity and much more efforts are required to suppress such word. Therefore, even a normal person makes a mistake in saying a wrong word that has a certain extent of semantic similarity but is different from the intended word in distracting circumstances with cognitive burden. Based on such hypothesis, frequent appearance of category errors in the normal group could be explained by decline of function to suppress other interfering words that have semantic association, i.e., by relating them to decline of executive function. Thus, the executive function deficits of the normal group are further confirmed in the analysis of errors.

Nevertheless, retrieval of words is easily interrupted by other words either due to executive function deficits or another different problem. In such circumstances, the lexicalization deficits can be considered in the word retrieval error,[24] which is not a cognitive problem but is a problem of language processing. The decline of semantic category fluency in the group with MCI is due to small quantity of words stored, the lexicalization deficits, or both. However, the finding that category errors were less frequent in the group with MCI than the normal group suggests that the difficulties faced by the MCI group in the task performance are caused by neither executive dysfunction nor lexicalization deficits. Consequently, the difficulty of the group with MCI resulted from the reduced amount of words in storage. Similar interpretation was made in precedent studies[11,12] that explained the semantic category fluency deficits of the group with Alzheimer's disease as a problem of semantic memory repository. Thus, the MCI can be confirmed as a stage of cognitive deficits in the progression

of dementia.

The results of significantly higher incidences of repeated errors in the un-cued semantic category fluency and the category errors in the cued semantic category fluency, respectively, are likely to be explained in terms of the nature of the tasks. The un-cued semantic category fluency task was performed for 60 seconds, while the cued semantic category fluency task was performed 4 times of 15 seconds each. Since the un-cued semantic category fluency task had longer time allowed per category, repeated error was higher as a result of repeated reproduction of the same word in a relatively long task time. In addition, in the un-cued semantic category fluency task, even if a word was generated by wrongly selecting the one belonged to another sub-categories, it was highly likely not to be an error if it is belonged to the supra-category "Animal". Whereas, in the cued semantic category fluency task, the sub-categories are predetermined and if deviated from that category, it becomes the category error. Thus, the failure in suppression of interrupting words is revealed easily in the cued semantic category fluency task, with significantly higher frequency of category error than the un-cued semantic category fluency.

Finally, the result of the inter-task correlation analysis of higher correlation coefficients of the confrontation naming task and the cued semantic category fluency task than un-cued semantic category fluency, implicates greater language generation ability than any other cognitive processing abilities for the cued semantic category fluency task. The un-cued semantic category fluency task is to examine not only linguistic aspects but also cognitive strategy function inclusively, thus, low correlation coefficients with both confrontation naming and the cued semantic category fluency task is as expected. In summary, the un-cued semantic category fluency by general method is a task to evaluate both functions of clustering and switching; whereas, the cued semantic category fluency conducted in this study is a more efficient task to evaluate the clustering function.

This study suggested that deficits of the group with MCI could be attributed to the problem of clustering rather than of switching function, by comparing the performance of semantic category fluency depending on cueing. In addition, the differences in performance from the normal group was significant in the cued semantic category fluency task but not significant in the un-cued semantic category fluency. Such result somewhat clarifies why previous studies could not agree upon consistent conclusion for the semantic category fluency of the group with MCI. The semantic category fluency task simultaneously examines the language and the cognitive function and is thus, a very useful task; however, when it is difficult to determine whether the problem of patient is due to language deficits or cognitive deficits, it can be the limitation of the task. Combined performance of the cued tasks may be a method to resolve such limitation. Therefore, if the un-cued semantic category fluency as well as the cued semantic category fluency task are conducted in clinical practice, and the results are interpreted comprehensively, significant information would be acquired for accessing the underlying deficits of patient.

Despite such significance, this study has a few methodological limitations as well. The largest limitation is the limit of generalization due to small number of study subjects. In addition, the low education level of the subject should be considered for the interpretation of the results. Given such limitations, result of no significant group wise differences in the un-cued semantic category fluency should be cautiously interpreted. In this study, the normal group seemed also to have difficulties in performing the un-cued task, because they scored 11.08 points (SD; 3.44) in un-cued semantic category fluency. This score is substantially lower than the study results of Park et al.[21] The age and the years of education identified in the normal group can be considered as one of the reasons for such differences presented by each study. The subjects of this study were older with lower education levels in average, as compared to those in the study of Park et al.[21] In our study, since the normal group included old aged subjects with lower education level, it is possible that the differences from the group with MCI are not significant. Thus, further studies are required using normal subjects and subjects with MCI with higher, as well as more diversified level of education.

Conflicts of Interest

The authors have no financial conflicts of interest.

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