Kobe University Repository : Kernel

PDF issue: 2026-11-19

Effects of verbalization on deficits of general attention in patients with unilateral spatial neglect

Seki, Keiko
Ishiai, Sumio
Koyama, Yasumasa
Nakano, Naomi
Koizumi, Tomoe

(Citation)
Bulletin of health sciences Kobe,18:1-10

(Issue Date)
2002-12-20

(Resource Type)
departmental bulletin paper

(Version)
Version of Record

(JaLCDOI)
https://doi.org/10.24546/00331150

(URL)
https://hdl.handle.net/20.500.14094/00331150

KOBE UNIVERSITY

Effects of verbalization on deficits of general attention in patients with unilateral spatial neglect

Keiko Seki[1], Sumio Ishiai[2], Yasumasa Koyama[2], Naomi Nakano[2] and Tomoe Koizumi[2]

Unilateral spatial neglect is the failure to attend to and explore stimuli presented in the space contralateral to the brain lesion. Persisting unilateral spatial neglect disturbs the daily activities of patients, and it often reduces effectiveness of motor rehabilitation. Although neglect is basically a deficit of spatial attention, its strong linkage with deficits of general attention is suggested. If general attention training, such as verbalization, can modulate neglect performance, this may provide another approach for neglect rehabilitation.
Accordingly, this study aimed to examine effects of verbalization on tasks requiring general attention. In Experiment 1, test adequacy was examined in 35 neglect patients and 12 normal controls. Copying of models that include a basic element in a sequence fit for our purpose. In Experiment 2, effect of verbalization was examined in five neglect patients and the 12 controls. The results showed that (1) all patients were unaware of the number of basic elements appeared in each model, and (2) they succeeded in copying when requested to count the number, but never used this strategy voluntarily. Effect of verbalization was obvious, but generalization of this effective strategy to daily activities seemed to be the problem.

Key Words: Unilateral spatial neglect, General attention, Verbalization, Improvement

Introduction

Unilateral spatial neglect is the failure of brain damaged patients to attend to and explore stimuli presented in the space contralateral to their lesion[1)]. Left unilateral spatial neglect followed by the right hemisphere stroke is much more common and severe than right unilateral spatial neglect followed by the left hemisphere stroke. Patients with left unilateral spatial neglect often collide with objects on their left side, fail to eat from the left side of the plate, and ignore objects and people on the left side. Persisting unilateral spatial neglect disturbs the daily activities of patients, and moreover, it often reduces effectiveness of motor rehabilitation[2-3)].

Although unilateral spatial neglect is predominantly explained in terms of disorder of spatial attention[4-8)], most researchers consider that it is not a single deficit but constitutes several related

Faculty of Health Sciences, Kobe University School of Medicine[1], Kobe, Japan, and Department of Rehabilitation, Tokyo Metropolitan Institute for Neurosciences[2], Tokyo, Japan

deficits such as directional hypokinesia[9], and representational deficits[10]. Non-spatial problems obviously affect unilateral spatial neglect as well, since neglect performance often fluctuates by motivation[11], instruction[12], task demands[13-14], and fatigue[15].

There have been many attempts to improve unilateral spatial neglect, but most of them show only temporal effects[16-18]. Among them, study of Robertson et al.[19] has implications for rehabilitation, since it showed improvement of lateralized neglect performance by training of non-lateralized attention, namely, sustained attention. Their procedures involve training subjects to improve their internal control of attention by self-instructional techniques. It seems that verbalization plays an important role to control neglect performances. They consider that the spatial imbalance in neglect can be reduced by manipulations of the nonlateralized attentional capacity through verbalization. In fact, many studies point out that unilateral spatial neglect is strongly associated with a fundamental loss of general attentional capacity, such as sustained attention, focused attention, and divided attention[20-22]. It is suggested that attentional capacity is represented in the right hemisphere, and in particular the frontal lobe[23-25]. Therefore, neglect patients with the right hemisphere damage possibly perform better on tasks requiring general attention with the help of verbalization. If it is true, training that focuses on verbalization may have great effects in improving neglect performance.

Accordingly, we conducted this study to find out effects of verbalization on tasks that require capacity of general attention. Tasks examining the aspect of selectivity (focused and divided attention) are generally simpler than those examining the aspect of intensity (sustained attention and alertness). Accordingly, we selected reproduction tasks using targets with repeated elements, since our previous study[26] suggested influence of attentional capacity on repetitive performance (Fig.1).



Figure 1. Examples of duplication and omission errors observed in dictation of kanji letters with repeated elements. Errors occur in either left, right, top, or bottom radical (from Seki et al., 1998[26]).

Experiment 1

Subjects and Methods

Subjects were 35 right-handed patients (22 males and 13 females) following a unilateral right hemisphere stroke (mean age = 66.1 years, SD = 8.9). The mean duration from the onset of the stroke to the study was 9.2 months (SD = 9.6). All suffered from unilateral spatial neglect. Their severity of unilateral spatial neglect was evaluated according to the method described elsewhere[27-28]. Twenty-three patients had mild neglect, 9 had moderate neglect, and the remaining 3 had severe neglect. Their lesion localizations were examined by CT and/or MRI. In 30 patients, the lesion was mainly located in the parietal lobe and extended to the frontal and temporal lobes. Two patients suffering from posterior cerebral artery infarction had lesions in the occipital lobe and thalamus. The remaining three patients had putaminal hemorrhage. Eighteen patients had a left homonymous hemianopia on confrontation testing. Three had an incomplete left homonymous hemianopia and five had a left inferior quadrantanopia. The remaining nine had no visual field defect but showed left-sided extinction on double simultaneous stimulation. All patients were examined with the Wechsler Adult Intelligence Scale-Revised (WAIS-R), Japanese edition[29]. Their verbal IQ varied from 70 to 105 (mean = 89.0, SD = 12.3). All used only their right hand in each test, since all had apparent hemiparesis. Twelve age-matched healthy controls also participated in this study (mean age = 69.5 years, SD = 8.8). All subjects gave informed consent to this study.

Tasks selected for this experiment were dictation of kanji letters, target detection tasks (vowel /a/ and a red mark presented auditory or visually at a rate of one per second), tapping, repetition of syllable /pa/, and copying of spiral shapes. In target detection tasks, the subjects were told to listen to or look at the stimulus very carefully. They were instructed to refrain from responding non-targets, but to respond to the targets that were occasionally presented. The rate of presentation of the targets was set at 20%. In the tapping and repetition tasks, the examiner tapped her hand on the table or repeated syllable /pa/ twice, three times, four times, or five times. In the copying task, spiral shapes with a sequence of two, three, four, or five basic elements were presented. The subjects were requested to copy or repeat the models as precisely as possible. We defined error as incorrect number of sequences, so other poor performances in terms of construction and motor movement were ignored. Accordingly, the examiner never mentioned about the number of basic elements each model included.

Results

There was a significant difference in the mean numbers of errors between the two subject groups in two out of the three tasks of dictation and target detection (Mann-Whitney U test, $P < 0.001$ in dictation of kanji and $P < 0.01$ in visual target detection task) (Fig. 2). It is worth noting that the normal controls also produced some errors in these tasks (dictation of kanji: mean = 0.3, SD = 0.5; auditory target detection task:

mean = 1.3, SD = 1.2; visual target detection task: mean = 0.7, SD = 1.1). On the other hand, the controls never made errors in any of the tapping, repetition, and copying tasks (Fig. 3). The results of the control subjects indicated that these three tasks were easy enough for them. However, all but three patients erred either in one, two, or all three tasks, and their performance in each task was significantly worse than that of the controls (Mann-Whitney U test, $P < 0.01$ or less in all three tasks). The numbers of patients who produced errors were 14 out of 30 (46.7%) in the tapping task, 17 out of 22 (77.3%) in the repetition task, and 19 out of 29 (65.5%) in the copying task.

Discussion

It was found that the normal controls performed significantly better than the patients in five out of the six tasks (Figs.2 and 3). Tapping, repetition, and copying seemed to be appropriate for our purpose, since the normal controls showed perfect performance in these tasks (Fig.3). The number of the

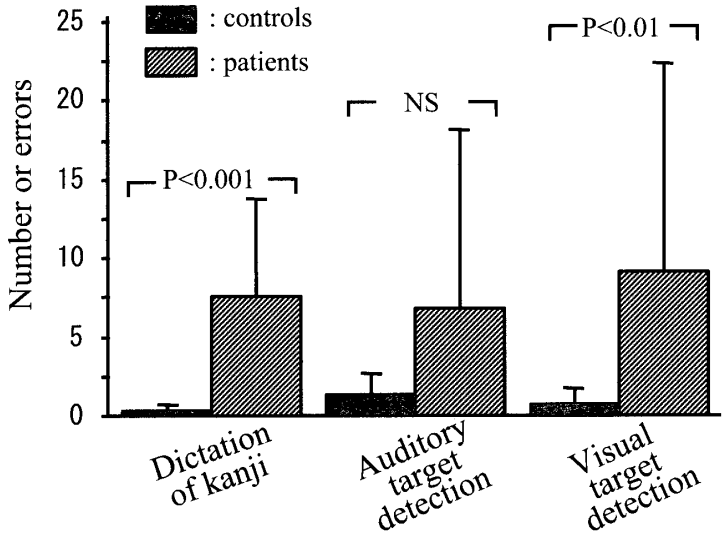


Figure 2. Number of errors in each task

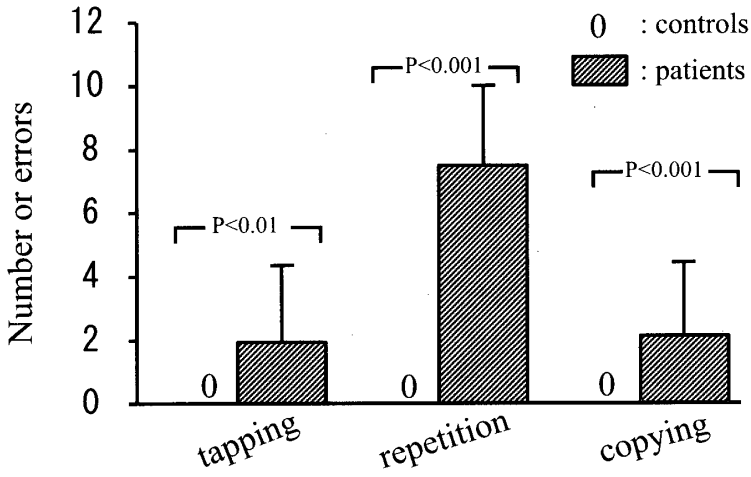


Figure 3. Number of errors in each task

patients who produced errors varied among the three tasks. This difference may be explained by the task demands. The tapping task seemed the easiest of the three tasks. In this task, information could be processed both visually and auditorily, since the subjects were allowed to see the examiner moving her hand up and down while they heard the sound of tapping. Similarly, in the repetition task, the subjects could see the examiner's articulatory movement while they heard the target sound. Although visual information was available, more than half of the patients closed their eyes during the task. This may be the reason that more patients erred in this task than the other two. In the copying task, only visual information was available, thus the task was regarded as the most difficult of the three. The subjects had to achieve the task by comparing their copy with the model carefully. Although the task was simple and easy for the controls, it was too attention-demanding for our patients to perform. We thus concluded that copying of a basic element in a sequence was the most appropriate task for detecting disorders of general attention.

The number of the subjects who showed flawless copying performance was three out of five for the patients with the lesion to the subcortical structure (basal ganglia and thalamus), while it was seven out of 24 for the patients with the apparent frontal lesion. The occurance rate of the patients with perfect performance did not significantly differ between the two lesion groups (Fisher's exact method, $0.1 < P$). The result demonstrates the possibility that the subcortical lesions affect attentional capacity as the frontal lesions do, as reported in some studies[30-31].

Experiment 2

Based on the results of Experiment 1, we conducted another experiment using the new task and new patients.

Subjects and Methods

Subjects were five right-handed patients (four males and a female) with unilateral spatial neglect. Their age ranged from 51 to 77 years (mean = 62.0, SD = 9.7). The mean post-onset duration was 9.3 months (SD = 5.7). Their score of Mini-Mental State Examination (MMSE)[32] ranged from 17 to 26 (Mean = 21.0, SD = 4.6). Their severity of unilateral spatial neglect was assessed by Behavioural Inattention Test (BIT), Japanese edition[33]. Their BIT score ranged from 42 to 118 (mean = 75.6, SD = 33.0). All patients were regarded to have relatively severe neglect. Three patients suffered from putaminal hemorrhage, and one patient from thalamic hemorrhage. The remaining one patient had large lesions involving the frontal, parietal, and temporal lobes. Three patients had left homonymous hemianopia, and the other two had left inferior quadrantanopia. All had left hemiparesis, and used only their right hand in performing the tasks. The same healthy normal controls in the Experiment 1 joined the study. All subjects gave informed consent to participate in this study.

Elliptic and zigzag shapes were added to the spiral shapes used in the Experiment 1 as the models for copying. Both materials included a sequence of two, three, four, or five basic elements. Each shape was ran-

domly presented twice for copying, and the number of errors was counted for each subject. Figure 4 shows the examples of the models.

The procedure for the tasks was the same as in Experiment 1, except that the examiner asked the subjects, immediately after they finished copying, whether they had paid attention to the number of basic elements. Then, the examiner let them count the number of sequences, and asked them to copy again until they were sure that their reproduction was exactly the same as the model in terms of the number of basic elements. The simple copying task without counting was inserted between the two blocks of copying task with counting in two subjects (SM and MI). This ABA design enabled us to examine effects of verbalization on the copying performance.

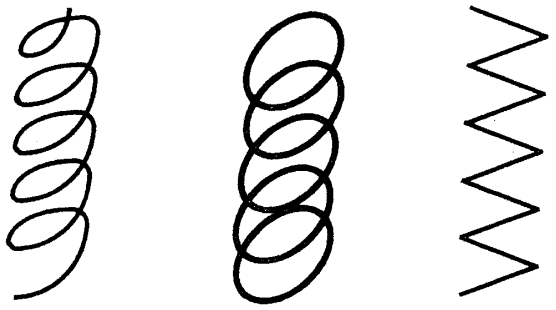


Figure 4. Examples of spiral, elliptic, and zigzag models used in Experiment 2. Basic element appears five times in each model.

Results

Normal controls showed no copying error in any of the three materials. They voluntarily counted the number of basic elements before they started copying. On the contrary, all except patient YF showed errors in most trials. It was revealed that all patients, including patient YF who generally showed fair performance on this task, paid no attention to the number of basic elements each model contained. On their evaluation of their copies, they adhered trifle points such as patchy lines and poor construction but overlooked the number of sequences. As a result, they made duplication and omission errors. Although the patients performed significantly worse than the controls (Mann-Whitney U test, $P<0.01$ or less), there was no significant difference in the

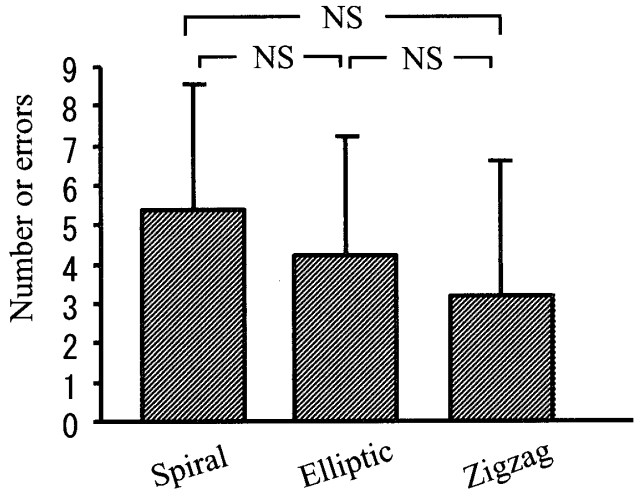


Figure 5. Number of errors in copying each model

mean number of errors among the three models (Fig. 5). The number of errors did not significantly differ between the two patient groups classified in terms of age, post-stroke duration, MMSE score, and BIT score (Mann-Whitney U test, $0.14 < P$ or more). The two patients (SM and MI) who performed simple copying task immediately after copying with counting did not use the counting strategy voluntarily. As shown in Figure 6, there was a tendency that the mean number of errors was fewer when they copied with verbalization than they did without it (Wilcoxon's signed rank test, $P < 0.06$).

Discussion

The most striking observation is that patients with unilateral spatial neglect never paid attention to the number of the basic elements. It was also true for the patient who showed almost perfect performance on this task. It is unlikely that their deficits resulted from perseveration[34], a sign of the frontal damage, since the same person committed perseverative duplication errors and non-persevarative omission errors under the same task demands. Therefore, their deficits should be considered to be attentional[21] in nature. Moreover, their performance was almost the same regardless of the model simplicity. It was suggested that their attentional capacity was so limited that they could not divide their attention to the number of sequences of basic elements while copying[25]. Consequently, they erred even when copying the easiest zigzag models. On the contrary, normal controls voluntarily counted the number, and reproduced perfect copies. It is apparent that our neglect patients showed lowered level of selective attention.

When counting was introduced immediately after simple copying, dramatic improvement of performance was observed. The patients showed flawless counting, and reproduced perfect copies. It is obvious that counting helped them to reproduce perfect copy. In this sense, verbalization reduced

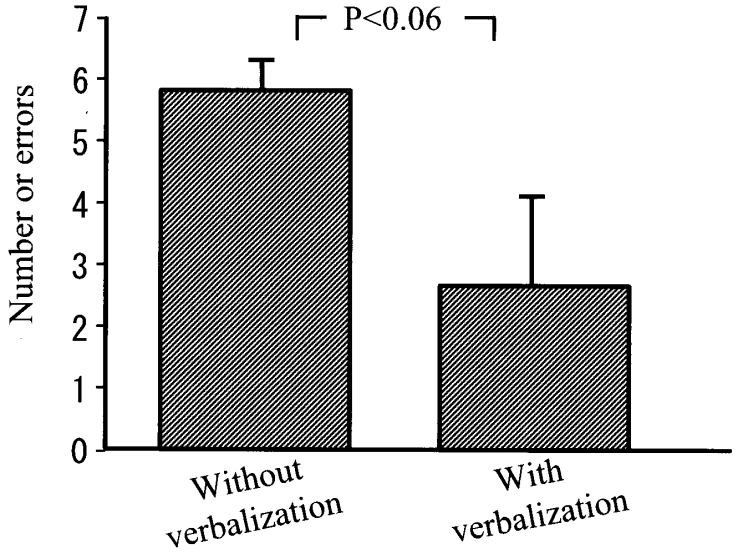


Figure 6. Copying performance with or without verbalization

their deficits. Nevertheless, they erred again in the trials of copying without counting. This means that counting strategy did not work when they were allowed to copy freely by their own strategy. Unfortunately, this external cue did not work properly, unless neglect patients used this strategy as a self-generated cue. This result is in line with other reports describing that significant effects of training was restricted to the task on which it was specifically trained[16-18),35)]. This is a problem of generalization frequently observed in rehabilitational settings.

The task we used to examine disorders of attention is considered to represent a measure of the selectivity aspect of attention, which refers to select one source of information or one target stimulus among other distractors (focused attention) and ability to attend and respond simultaneously to multiple sources of task-relevant information (divided attention)[25)]. Although our task partly resembles other tests of attention, such as Attentional Capacity Test (APT)[36)] and Luria's task[34)], ours is simple and sensitive for defective attentional capacity.

Four out of five patients (80%) demonstrated deficits of general attention. Three patients had lesions in the basal ganglia or thalamus, and one had a large lesion including the frontal lobe. It is argued that lesions in the basal ganglia and thalamus often result in unilateral spatial neglect, and at the same time, cause deficits of attention[30-31)]. Our results may support this argument. However, it should be noted that one patient who suffered from putaminal hemorrhage did not show defective performance. Although he had severe (his BIT score was 94) and chronic neglect (his post-onset duration was 4.5 months), he was young (57 years old), and well-oriented (his MMSE score was 26). He was very cautious when copying. He never counted the number of basic elements but frequently compared his copy with the model. His strategy of comparison is considered to have almost the same effects as counting. Although some patients were in a status similar to or better than him in terms of neglect severity, post-onset duration, age, or MMSE score, his status seemed most favorable as a whole. The most influential factor is, however, still unclear. Further studies are awaited on this issue.

General Discussion

Our copying task is considered to be appropriate tool to evaluate deficit of general attention. Our neglect patients dramatically improved their task performance by verbal counting. Apparently, verbal cues reduced deficits of general attention. However, we should not conclude that verbalization improves unilateral spatial neglect in any case. It must be noted that such external verbal cue had very limited effects on their performance. This means that although rehabilitation staffs call out to a neglect patient enthusiastically, or even the patient himself repeats after the therapist, verbal cues do not work properly. The most important thing is to make the patients use such verbal strategy as voluntary self-generated cue to control their behavior.

References

1. Heilman KM, Bowers D, Valenstein E, et al. Hemispace and hemispatial neglect. (In) M. Jeanerod (Ed.) Neurophysiological and neuropsychological aspects of spatial neglect. Amsterdam, Elsevier, pp. 115-150, 1987.
2. Denes G, Semenza C, Stoppa E, et al. Unilateral spatial neglect and recovery from himiplegia—A follow-up study. Brain 105:543-552, 1982.
3. Gialanella B, Mattioli F. Anosognosia and exptrpersonal neglect as predictors of functional recovery following right hemisphere stroke. Neuropsychol Rehabil 2:169-178, 1992.
4. Mesulam, MM. A cortical network for directed attention and unilateral neglect. Ann Neurol 10:309-325, 1981.
5. Mark VW, Kooistra CA, Heilman KM. Hemispatial neglect affected by non-neglected stimuli. Neurology 38:1207-1211, 1988.
6. De Renzi E, Gentilini P, Faglioni P et al. Attentional shift towards the rightmost stimuli in patients with left visual neglect. Cortex 25:231-237 1989.
7. Seki K, Ishiai S, Koyama Y, et al. Appearance and disappearance of unilateral spatial neglect for an object: Influence of attention-attracting peripheral stimuli. Neuropsychologia 34:819-826, 1996.
8. Corbetta M, Miezin FM, Schwartz HD, et al. A PET study of visuospatial attention. J Neurosci 13:1202-1206, 1993.
9. Heilman KM, Bowers D, Coslett HB, et al. Directional hypokinesia: prolonged reaction times for leftward movements in patients with right hemisphere lesions and neglect. Neurology 35:855, 1985.
10. Bisiach E, Luzzzatti C. Unilateral neglect of representational space. Cortex 14:129-133, 1978.
11. Ishiai S, Sugishita M, Odajima N, et al. Improvement of unilateral spatial neglect with numbering. Neurology 40:1395-1398, 1990.
12. Ishiai S, Seki K, Koyama Y, et al. Disappearance of unilateral spatial neglect following a simple instruction. J Neurol Neurosurg Psychiat 63:23-27, 1997.
13. Seki K, Ishiai S, Koyama Y. et al. Unassociated responses to two related task demands: A negative factor for improvement of unilateral spatial neglect. Neuropsychologia 37:75-82, 1999.
14. Seki K, Ishiai S, Koyama Y, et al. Why are some patients with severe neglect can copy a cube? The significance of verbal intelligence. Neuropsychologia 38:1466-1472, 2000.
15. Weinstein E, Friedland R. Behavioral disorders associated with hemi-inattention (In) Advances in Neurology New York, Raven Press, pp. 51-61, 1977.
16. Ross FL. The use of computers in occupational therapy for visual scanning training. Am J Occup Ther 46:314-322, 1994.
17. Fanthome Y, Lincoln NB, Drummond A, et al. The treatment of visual neglect using feedback of eye movements: A pilot study. Disabil Rehabil 17:413-417, 1995.
18. Halligan PW, Donegan C, Marshall JC. When is a cue not a cue? On the intractability of visuospatial neglect. Neuropsychol Rehabil 2:283-293, 1992.
19. Robertson IH, Tegner R, Tham K, et al. Sustained attention training for unilateral neglect: Theoretical and rehabilitation implications. J Clin Exp Neuropsychol 17:416-430, 1995.
20. Robertson IH, Halligan PW. Spatial Neglect. A clinical handbook for diagnosis and treatment. Hove, Psychology Press, pp. 121-142, 1999.
21. Smuelsson H, Hjelmquist EK, Jensen C, et al. Nonlateralized attentional deficits: An important component behind persisting visuospatial neglect? J Clin Exp Neuropsychol 20:73-87, 1998.
22. Robertson IH. Do we need the "lateral" in unilateral neglect? Spatially nonselective attention deficits in unilateral neglect and their implications for rehabilitation.

Neuroimage 14:85-90, 2001.
23. Pardo JV, Fox PT, Raichle ME. Localization of human system for sustained attention by positron emission tomography. Nature, 349:61-64, 1991.
24. Posner MI, Petersen SE. The attention system of the human brain. Ann Rev Neurosci 13:25-42, 1990.
25. Van Zomeren AH, Brouwer WH. Clinical Neuropsychology of Attention. New York, Oxford University Press, 1994.
26. Seki K, Ishiai S, Koyama Y. Effects of unilateral spatial neglect on spatial agraphia of kana and kanji letters. Brain Lang 63:256-275, 1998.
27. Ishiai S, Furukawa T, Tsukagoshi H. Visuospatial processes of line bisection and the mechanism underlying unilateral spatial neglect. Brain 112:1485-1502, 1989.
28. Seki K, Ishiai S. Diverse patterns of performances in copying and severity of unilateral spatial neglect. J Neurol 243:1-8, 1996.
29. Wechler D. The Wechler Adult Intelligence Scale-Revised: Japanese Edition. Tokyo Nihonbunkakagakusha, 1990.
30. Hager F, Volz HP, Gaser C et al. Challenging the anterior attentional system with a continuous performance task: a functional magnetic resonance imaging approach. Eur Arch Psychiatry Clin Neurosci 248:161-170, 1998.
31. Rafal RD, Posner MI. Deficits in human visual spatial attention following thalamic lesions. Proc Natl Acad Sci USA 84: 7349-7353, 1987.
32. Folstein MF, Folstein SA, McHugh PR. "Mini-Mental State". A practical method for grading the cognitive state of patients for the clinician. J Psychiat Res 12:189-198, 1975.
33. Wilson B, Cockburn J, Halligan P. Behavioural inattention test, Japanese Edition. Tokyo, Shinkoigakushuppansha, 1999.
34. Luria AR. Higher cortical functions in man. New York, Basic Books, 1966.
35. Webster J, Jones S, Blanton P, et al. Visual scanning training with stroke patients. Behav Ther 15:129-143, 1984.
36. Weber AM. A new clinical measure of attention: The Attentional Capacity Test. Neuropsychology 2:59-71, 1988.