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A newly developed assessment scale for attentional disturbance based on behavioral problems: Behavioral Assessment of Attentional Disturbance (BAAD)

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Attentional disturbance following brain damage has been commonly evaluated by having the patients perform neuropsychological tasks. In rehabilitation settings, however, the primary concern is not task performance, but functional real-world behaviors. The aim of this study was to investigate the reliability and validity of a newly developed system for rating attentional behavior (Behavior Assessment of Attentional Disturbance, BAAD). The subjects included 183 patients with various types of brain damage. The initial form of BAAD consisted of 12 items to be completed by each patient's occupational therapist. Each item was rated based on the frequency with which the problem behaviors appeared during daily sessions of occupational therapy in the course of a week. A principle component analysis (factor analysis) with varimax rotation identified three principle factors which together explained 69.2% of the total variance. These components were regarded as related to "arousal", "sustained attention", and "selective attention". A final version of the BAAD scale with six items was developed by excluding all items with no significant relation to the aforementioned factors. The scale had a Cronbach's alpha coefficient of 0.81. The intraclass correlations for intra- and inter-rater reliability were 0.94 and 0.84, respectively. The BAAD score was significantly correlated with the patients' performance on the neuropsychological tests. The results indicate that the BAAD has good reliability and validity.

Key words: attention, rehabilitation, behavioral assessment, cognitive function

INTRODUCTION

"Attention" is the most fundamental function for the process of cognitive performance [7]. Regrettably this function is sometimes impaired following various types of brain damage. Attention deficit is difficult to measure [13]. The crucial clinical task of assessing attentional deficits has commonly been accomplished by tasks or tests such as PASAT (paced auditory serial addition task), TMT (trail making test), SDMT (symbol digit modality test), Stroop Color Word test, digit span, and various types of cancellation tasks [3, 11]. In rehabilitation settings, on the other hand, the primary concern is not task performance, but functional real-world behaviors.

Only a few rating scales of attentional behaviour have been developed for assessing attentional deficits. Ponsford *et al*. have addressed this issue by designing a rating scale for attentional behavior (RSAB) to be completed by the therapists treating the head-injured patients under assessment [6]. The RSAB rates 14 types of attentional behavior. Whyte *et al*. have also been trying to develop such scale. The results of the preliminary study have recently been reported [13]. There is, however, no Japanese rating scale of attentional behaviour suitable for Japanese actual situation of rehabilitation clinics. The authors have, therefore, developed an original system for rating attentional behavior (Behavior Assessment of Attentional Disturbance, BAAD) based on individual scores for 12 items.

In the present study we analyzed the factor structure of BAAD, re-selected the significant items through a method of high factor loading, newly developed a final BAAD version using the re-selected items, and investigated the reliability and validity of newly developed final version.

MATERIALS AND METHOD

We randomly selected the subjects as the participants for the present study from inpatients and outpatients with disease or trauma of the brain and with GCS (Glasgow Coma Scale) score of 14 or 15. All subjects received occupational therapy in the rehabilitation ward in our hospital. A total of 183 patients (126 male and 57 females) enrolled (Table 1). The patients ranged in age from 21 to 88 years, with a mean of 62. The time from onset ranged from 3 days to 10 years (median, 72 days). All subjects gave their informed consent to be studied.

The initial form of BAAD consists of 12 items thought to be associated with attentional behaviors (BAAD-12) (Table 2). The 12 items were originally developed by the authors. Through the preliminary use of this scale, problematic items were re-phrased. The assessment is completed by the patient's therapist (OT, occupational therapist). Each item is rated by the rater

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Table 1 Detail of clinical diagnosis

diagnosis	n
cerebral infarction	91
cerebral hemorrhage	56
subarachnoid hemorrhage	14
traumatic brain injury	12
others (brain tumor, encephalitis, etc.)	10
total	183

The subjects included 183 patients (126 male and 57 females) with disease or trauma of the brain.

Table 2 The 12 items in the Behavioral Assessment of Attentional Disturbance (BAAD-12)

item no	frequency
1. The patient is lethargic.	(0, 1, 2, 3)
2. The patient falls asleep during rehabilitation activities.	(0, 1, 2, 3)
3. The patient is restless.	(0, 1, 2, 3)
4. The patient makes no eye contact when the therapist speaks to the patient.	(0, 1, 2, 3)
5. The patient does not concentrate on the training task and his attention is easily distracted.	(0, 1, 2, 3)
6. The patient is easily tired.	(0, 1, 2, 3)
7. The patient shows no or slow verbal response to utterances from the therapist.	(0, 1, 2, 3)
8. The patient moves slowly.	(0, 1, 2, 3)
9. The therapist must urge the patient to start things.	(0, 1, 2, 3)
10. The patient would stop moving if not continuously pressed by the therapist.	(0, 1, 2, 3)
11. The patient repeats the same mistakes due to inattention.	(0, 1, 2, 3)
12. The patient is careless about important things he is doing.	(0, 1, 2, 3)
The frequency of appearance of the above types of inappropriate behavior is classified as follows: 0 = no occasions; 1 = below 50% of the occasions; 2 = 50% or more of the occasions; 3 = always.	sum of the score (/36)

on a scale from 0 to 3, indicating the frequency with which the problem behaviors appeared during daily sessions of occupational therapy in the course of a week (0 = no occasions; 1 = below 50% of occasions; 2 = 50% or more of the occasions; 3 = always). A simple sum is determined for each score (possible values from 0 to 36). A higher score indicates severer impairment.

For 31 of the subjects randomly selected, the BAAD-12 score during the physical therapy was also assessed by the patient's physical therapist (PT) on the same days to investigate the inter-rater reliability. The same OT reevaluated these patients one week after the initial administration (intra-rater reliability). Forty-three consecutive subjects who enrolled late in the course of the study were also assessed by the RSAB.

Each subject also underwent several neuropsychological tests (PASAT, parts A and B of TMT, and Digit Symbol subtest of WAIS-R, hereafter DS) commonly used for assessing attentional disturbance. Subjects, unable to complete these tasks due to aphasia, severe dysarthria, or other reasons were excluded from the analysis.

In PASAT, a random series of 61 digits are auditorily presented and the subjects are required to add each digit to the one preceding it [4]. The presentation interval of the digits in the present study was 2s.

The Japanese version of the TMT has already been reported in detail elsewhere [9]. Previous studies have shown that the non-dominant hand can be used as an alternative hand in the TMT and can be expected to perform comparably to the dominant hand [9, 10]. Accordingly, we asked the subjects with dysmobility of the dominant hand in the present study to perform the TMT with the non-dominant hand.

An earlier paper has reported the results of PASAT and TMT assessment in normal Japanese subjects in five age groups broken down by decade (20's to 60's) [8]. As the performances appeared to be considerably influenced by the subjects' ages, we used the following method to adjust the age bias before comparing the results across the subjects:

age-corrected value = (total number of correct answers [PASAT] or total completion time [TMT] / the corresponding mean value of normal subjects in the same age decade [8]) × 100

Thus, an age-corrected value of 100 for PASAT and TMT indicates the mean of normal subjects in the same age decades.

In terms of DS, age-corrected values obtained by a conversion table, which was prepared in the WAIS-R test package, were used for the statistical analysis.

The principle component analysis (factor analysis) with varimax rotation was used to determine how items in BAAD-12 would cluster. Only factors with an

Table 3 Rotated factor matrix from the factor analysis of the BAAD-6 score

no of items	factor 1 "arousal"	factor 2 "sustained attention"	factor 3 "selective attention"
1	**0.805**		
2	0.463		0.466
3		**0.979**	
4	0.515	0.573	
5		**0.751**	
6	0.513		0.530
7	0.738		0.404
8	**0.863**		
9	0.651	0.400	
10	0.552	0.654	
11			**0.744**
12			**0.859**

Through the factor analysis, three factors with eigenvalues above 1.0 are extracted from the BAAD-12. Only items with a statistical load of 0.4 or more to a factor are presented in this table. Items were considered to significantly belong to a factor when they correlated strongly (>0.6) within the factor and less strongly with other factors (<0.4). These items are underlined in bold font.

Table 4 The intra- and inter-rater reliability of BAAD-6

	intra-rater reliability	p	inter-rater reliability	p
ICC	0.94	0.0001	0.84	0.0001
Pearson's correlation coefficient	0.89	0.0001	0.73	0.0001
Mean (SD)	3.1 (4.2) *1 3.5 (4.8) *2	0.298*3	3.5(4.2) *4 4.2 (4.0) *5	0.267*3

ICC, intraclass correlation
*1, the 1st measure by OT; *2, the 2nd measure by OT; *3, p value of paired t-test; *4, assessed by OT; *5, assessed by PT

eigenvalue above 1.0 were further analyzed. Items were considered to significantly belong to a factor when they had good correlation's (>0.6) within the factor and were less well correlated with the other factors (<0.4) [1]. The items which failed to satisfy these criteria were deleted from BAAD-12. The shortened, final version of BAAD was developed by these procedures.

In the last phase of our study we investigated the reliability and validity of this new BAAD. The reliability was evaluated by determining Cronbach's alpha coefficient and the intraclass correlation (ICC). When several items are used to form a scale like BAAD, they should have internal consistency. Cronbach's alpha is a useful coefficient for assessing internal consistency. The ICC was used to investigate the difference between the two raters (OT vs PT) (inter-rater reliability) and also between two measurements by the same rater (OT) (intra-rater reliability). Pearson's correlation coefficient (r) was additionally calculated. The validity was assessed by examining the correlation between the BAAD scale and other neuropsychological measures of attention. We also investigated the correlations between the BAAD and RSAB scores. All analyses were undertaken using the SPSS, version 11.0 (SPSS Inc.).

Statistical significance was accepted at $p<0.05$.

RESULTS

The BAAD-12 score ranged from 0 to 34 in the present population. The factor analysis yielded three principle factors with eigenvalues above 1.0. Taken correctively, these factors accounted for 69.2% of the total variance. Table 3 shows the rotated factor matrix from the factor analysis. The first, second, and third components were considered to relate to "arousal", "sustained attention", and "selective attention", respectively. Accordingly, the three factors yielded were labeled as such. The "arousal", "sustained attention", and "selective attention" factors thus established accounted for 29.6%, 19.9%, and 19.7% of the variance, respectively. Six items (item no. 2, 4, 6, 7, 9, and 10) that failed to satisfy the aforementioned criteria were excluded from the BAAD-12 assessment. The remaining six items were significantly loaded on the three factors, with two items for each factor. Accordingly, the total score of the final version of BAAD (BAAD-6) can theoretically rang from 0 to 18. A strong significant correlation was found between BAAD-12 and BAAD-6 scores ($r = 0.97$, $P<0.0001$).

The BAAD-6 score on the present population ranged from 0 to 18, with a mean of 3.7. Fifty-three of the subjects scored 0, indicating no attentional deficit. Cronbach's alpha coefficient was 0.81 for the BAAD-6 assessment. Statistical results concerning the intra- and

Table 5 Correlation coefficients between the BAAD-6 score and the results of the neuropsychological tests

	r	p
PASAT	−0.40	<0.0001
TMT-A	0.47	<0.0001
TMT-B	0.19	0.047
DS	−0.21	0.016
RSAB	0.92	<0.0001

PASAT, paced auditory serial addition task [4]; TMT-A and B, Japanese version of parts A and B of the trail making test, respectively [9,10]; DS, digit symbol test, the subtest of WAIS-R; RSAB, rating scale of attentional behavior [6].

Table 5 Comparison of neuropsychological tests results between two groups with or without attentional deficit judged by BAAD-6

	group A	group B	p
Age (years)	63.1 (14.5)	61.8 (13.5)	ns
PASAT	99.1 (40.9)	57.2 (34.3)	<0.0001
TMT-A	109.9 (38.3)	183.1 (128.7)	<0.0001
TMT-B	123.5 (54.4)	186.6 (156.8)	0.002
DS	8.7 (2.8)	7.1 (2.9)	0.004

Group A and B consist of patients without and with attentional impairment judged by BAAD-6, respectively. The values are means (SDs). Results of all four of the tests are corrected by age. The PASAT and TMT values of 100 indicate the mean values of normal subjects in the same age groups (in decades). Therefore, a patient scoring below 100 in PASAT and above 100 in TMT has performed worse than the normal subjects in the same age group. On the other hand, a DS value of 10 is result for normal subjects. A patient scoring below 10, therefore, has performed below the average level of the normal population.
p, unpaired t-test; PASAT, paced auditory serial addition task [4]; TMT-A and B, Japanese version of parts A and B of the trail making test, respectively [9, 10]; DS, digit symbol test, the subtest of WAIS-R; sRSAB, rating scale of attentional behavior [6].

inter-rater reliability are shown in Table 4. A high ICC value (0.94, $p = 0.0001$) and Pearson's correlation coefficient ($r = 0.89$, $p = 0.0001$) were obtained between the two scores of the first and second administrations (intra-rater reliability). No significant difference was found between these two measurements. The ICC between OT and PT scores was 0.84 ($p = 0.0001$) (inter-rater reliability). Difference in the mean values of OT and PT assessment was statistically insignificant.

Table 5 shows the Pearson's correlation coefficient between the BAAD-6 score and the results of the neuropsychological tests. Higher BAAD-6 scores were significantly correlated with poorer performance on the tests.

The BAAD-6 and RSAB were well correlated with each other ($r = 0.92$, $p < 0.0001$).

We divided the present population into two groups based on the BAAD-6 scores. The first, group A, exclusively consisted of only patients who showed no attentional impairment according to the BAAD-6 assessment (i.e., the score was 0). The second, group B, included the remaining patients with scores of 1 or more. The results of the neuropsychological tests were compared between the two groups (Table 6).

Group A performed significantly better than group B in all of the tests. Group A scored a mean of almost 100 in the PASAT. This indicates that patients in group A are equal to normal subjects in the test performance. The age-corrected completion time of TMT, however, was slightly beyond 100 even in group A. This suggests that the result of this patient group is still worse than that of the age-matched normal subjects.

DISCUSSION

BAAD is a rating scale for attentional behaviors in Japan. In keeping with Ponsford's view that these types of ratings should ideally be performed by a therapist familiar with attentional behavior, BAAD is designed for the assessment of patient behavior by an OT [6].

Factor analysis identified three factors derived from the BAAD assessment: one related to "arousal", one related to "sustained attention", and one related to "selective attention". This finding is compatible with concept of the RSAB which was developed for the relation to three factors of alertness, selective attention, and sustained attention. No theoretical model for attention has yet been fully established. Van Zomeren *et al.* proposed a model of attention composed of alertness, selective attention, and sustained attention [6]. Whyte, in turn, proposed four components of attention: arousal, selec-

tion (focused attention), strategic control, and processing speed. Strategic control includes the ability to set, maintain, and modify performance goals, the ability to resist distraction by irrelevant information, the ability to flexibly switch attention back and forth between tasks, etc [12]. From this perspective, strategic control is therefore considered to correspond to sustained attention noted by Van Zomeren *et al*. In this sense, BAAD has these basic components of attention and may be theoretically appropriate as a tool for evaluating attentional behaviors.

The final version of BAAD consists of six items (BAAD-6). The assessment had a Cronbach's alpha of 0.81, indicating that the internal consistency was nearly satisfactory [2, 5].

Correlations between the ratings of the same raters were strong in the study by Ponsford ($r = 0.93$) [6], as well as our own ($r = 0.89$, ICC = 0.94). In terms of inter-rater reliability, Ponsford reported a relatively low Pearson's correlation coefficient ($r = 0.5$ to 0.6) between the ratings by the speech therapists (STs) and OTs [6]. Additionally, the STs assigned slightly higher scores than the OTs. In the present study, measurements in different contexts were compared between OT and PT. The ICC (0.84) and Pearson's correlation coefficient ($r = 0.73$) of the BAAD-6 scores were more satisfactory than the data by Ponsford. In addition, BAAD-6 scores did not significantly differ between PTs and OTs. Thus, it is possible that the BAAD assessment is not heavily influenced by the environment in which the attentional behaviors are observed and evaluated. This may be due to speculation that BAAD reflects fundamental and lower level of the attention process. This is supported by the results that the "arousal" factor shows the most marked load on the BAAD score. The lower level of attention process influences not only the task performance in the OT session, but also the basic physical activities that must be newly learned through physical therapy, such as transfer, wheel chair drive, gait, etc. Further study, however, will be needed to investigate the reliability of BAAD when used by ST.

The BAAD score significantly correlated with PASAT performance. While the correlation coefficient ($r = 0.40$) was by no means strong, it was almost identical to that reported by Ponsford ($r = 0.41$). The attention capacity presumed by the scores of the neuropsychological tests may diverge somewhat from the actual behavioral performance. The BAAD score was also found to be significantly correlated with TMT and DS in addition to PASAT. The RSAB and BAAD-6 scores correlated well with each other ($r = 0.92$). Therefore, the validity of BAAD is considered positive.

The subgroup of subjects with a BAAD-6 score of zero performed worse than the normal subjects in some of the neuropsychological tests. This suggests that some of the patients with a BAAD-6 score of zero may have had only very slight disturbances of attentional function. In other words, BAAD-6 may not be sensitive enough to detect minor attentional impairments.

The results indicate that BAAD-6 has a good reliability and validity. The assessment is easy to administer and can be applied for patients with communication disturbances. BAAD-6 can be completed quickly and may be clinically useful for evaluating attention, especially for severer cases, in rehabilitation settings.

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