The validity, diagnostic value and replicability of Bender Visual-Motor Gestalt Test in traumatic brain injury patients

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Original Article

Abstract

Introduction: Bender Gestalt test is one of the most famous neuropsychological tests that is simple and it can be used to examine brain injuries. The objective of this research was to investigate the validity, diagnostic strength and the replicability of the Bender Visual-Motor Gestalt Test in patients with traumatic brain injury (TBI).

Methods: 240 participants were tested in a case-control study to examine the validity of this test in two groups included 120 patients with TBI and normal cases. All participants were involved in the study by non-probability and consecutive sampling method. The normal group was matched with the TBI group in terms of age, gender and education level. The Bender Gestalt Test, neurological and dissectional information questionnaire, the demographic variable lists of the patients and the mini-mental examination test (MMSE) were used to collect the data.

Results: Findings showed that patients with TBI showed more frequency in Gestalt test's dozen errors than the normal group. The discriminant validity coefficient showed that, in total 98.3% of the participants had been placed correctly in two normal and patient groups. The concurrent validity coefficient with the MMSE was -0.53 and the item-total correlation of this test were in a range of 0.10 to 0.48. The replicability results of this test among three examiners through intraclass correlation coefficient (ICC) calculations were 0.81 and the cronbach's Alpha coefficient for the total sample was 0.85.

Conclusion: This test has an acceptable discriminant and replicability strength. Regarding the obtained validity and reliability coefficients, it is recommended that this test be applied with the paraclinical diagnostic tools (such as CT-scan and MRI) as the screening tools in patients with TBI.

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Introduction:

Neuropsyclogical tests are of psychological test groups with a remarkable progress in recent years. This test relates to analyze brain-treatment relationship based on changes in recognition and treatment along with brain injury. Depending on type, intensity and the injury place, brain injuries

create a few changes in various cognitive functions. So, neuropsychological test can effectively help clinical - neuro psychologists and neuropsychiatrists to answer clinical positions such as primary diagnosis of brain injury to determine weak and strong points in patients with cognitive disorders, to evaluate. Treatment and rehabilitation programs, to determine how to care the patient, prognosis of disease and so on (1,2).

Visual-motor Bendar Gestalt test presented by lorta Bender (1938) was a successful test for the erapists and neurologists to evaluate brain injuries (3). This test includes nine geometric forms extracted from a collection of 30 formations by vertimer (1923) indicating gestalt principles about perception 94). Vertimer emphasized the ability of normal people to respond to the designs in a cohesive method. Bender developed this topic and showed that how individual functional level due to delay in perception- motor growth and of the state also organic and functional pathology leads to disorder (5). In reality, many patients with cerebral disorder are not able to analyze combined motivational collections or to turn perception into suitable motor actions.

The appropriate test manifests a relatively high percent of function disorder in analytic- visual, spatial-visual, structural- visual items in the patient with brain injury specially those having injury in the right hemisphere (6). Basically, Bender Gestalt has been designed as one of the recognition tools for cerebral injury and probably above all used to recognize adult organic disorders (7). Russell has reported that Bender Gestalt is useful and sufficient to recognize the people with Scattered (dispersed) injury and are sensitive in dysfunction of parietal lobe in the right hemisphere.

Hinton analysis (8) showed that Bender Gestalt test with or without description has had the most success to neuro – psychology test. In a research by Hain (1963), Lacks and Marley (1982), Bender Gestalt test can separate the individuals with brain injury from healthy anes. Another study is done to show whether Bender Gestalts visual –motor test can diagnose cerebral injuries or not. The examinees include 45 patients with brain injury and 139 ones without it. All of them were men ranged 20-70 years old. The obtained results showed that when the result of Bender Gestalt test is compared with EEG, Bender Gestalt's motor-Visual test in screening individual with brain injury has a weaker function in comparison with EEG. In Iran, a few researches about Bender Gestalt test application to realize brain injuries have been performed. Saravani's study (10) indicated that Gestalt's test is unable to diagnose light function disorders in the brain. Tizdast (11) in his study, Bender's test efficiency to recognize brain injuries in comparison with CT scan method had been analyzed and showed no significant difference between recognition ability of Bender's test and CT scan method. Modares Garavi (9) in a study about Bender's efficiency in the healthy elderly showed that this test with cutting point6, sensitivity 57.7, Specialization 94.7 and efficiency 78.7 in lacks' grading system can separate educated elderly examinee with brain injury from the healthy one, In another survey by Hamid and Ghafari (12), a significant relationship was shown between every brain four lobes with dozen errors of Bender's test in patient with brain injury and finally they concluded that this test has a good recognition value to assess the brain injury.

The aim of recent research is to analyze validity, diagnostic strength, repicability of Benders' motor-visual test in patients with traumatic brain injury.

It is evident that implementing these researches and accessing special diagnostic protocols using nuero-cognitive tests due to facility in performance and lower expenses can play a valuable role to diagnose and screen the brain injuries.

Also, the result of this study can be available for psychological experts and psychiatric and counseling clinics that have ability to diagnose brain function injury method.

Methods:

The recent case- control study for Benders' test validation is done in khoram Abad nomadic martyrs hospitals and Pour Sina treatment–training center in Rasht Jun.to Dec. 2011, 120 patients with TBI in non-probability and consecutive sampling method entered the study and they were investigated after their informed consent.

It is necessary to explain that normal people were chosen among clients and patient

companions with traumatic brain injury who were homogenous with patients in age, gender and education. After patients evolution, a demographic questionnaire was given to them and Bender's test was presented after filling out the questionnaire and the same verbal tips related to patients with brain injury was used for normal people.

The entrance criteria to study were as following:

1. The age of 12 and over 12 in both groups, TBI and healthy people who were identical in age, gender and education. Selecting the minimum age of 12 is due to rebuilding every Benders' dozen designs, the individual should turn the seen design into motor activity and he will be able to do that when sensory unity and motor harmony attain an evolutionary level obtained usually after the first decade of life (4).
2. Local and scattered injury of brain tissue arising from an external cause.
3. Radiography or CT scan findings presenting skull fracture, intra cranial hemorrhage or chronic cerebral disorder.
4. No affliction to psychosis and mental retardation.
5. No affliction to optical disorders and also available motor- sensory disorders. S
6. Tay duration in hospital less than a month.

Also, the exit criteria from the research are following:

The patient with clinical or radiological tissues presenting spinal Cord injuries, The existence of every type of neurologic disease before TBI or brain injury with no traumatic source like brain tumors, stroke, aneurismal and other venial occurrence of brain. Patients with vegetative state and severe lack of consciousness leading to lack of responding to interviewer or tests. The patients who have no consent to enter the study in every reason. The following questionnaires were used in this research:

1. A questionnaire designed by researcher for about hospital information and demographic: including age, gender, marital status, education, residency, occurrence reason, and history after TBI, occupational position pre TBI, hospitalization duration in hospital different sections.

2. A questionnaire designed by researcher for about the evaluation of organic neurology and pathology of brain including the information such as: consciousness level, three hours after entrance to hospital (using Glasgow Coma Scale ((GCS))), the type of skull fracture regarding skull radiographic pictures in hemispheres injuries, cerebral injury position and local or scattered injury of brain regarding CT scan and physical trauma with TBI.

3. Mini-mental state examination. (MMSE): To measure the cognitive defect of patients with TBI, MMSE is used. This is a summarized method to assess cognitive function generally. It evaluates orientation, memory, estimation, writing and reading ability, Visual-spatial ability and speaking. MMSE has a broad application as a simple and rapid tool to evaluate probable Cognitive defects. MMSE has often been used as a screening tool to diagnose (Dementia and cognitive changes in neurologic and psychiatric and elderly patients) (13). Additionally, MMSE can be performed for hospitalized, outpatients, reception unit of nursering homes for the elderly above 65 years old and whenever, there's Concern about Cognitis ability. MMSE scores vary between 0-30 (14) and according to researches by Folstein et al (1973). Cutting Point 23.24 can distinguish between the patient with cognitive defect and healthy ones. Mendez and Cummings (2003) emphasized the cutting point.

4. Bender Gestalt visual-motor test: includes nine geometric pictorial cards in 4×6 inches with a picture on every card. The pictures were presented to studied individuals one by one and asked them to draw every picture on a white page (A4). The test is in individual method. The cards have been shown to the examine and according to the following verbal guidance by Hot as a standard method, the trial begins:

"I want to show you the cards one by one, a simple picture has been drawn on every card, I want you to draw these pictures as well as you can and as rapidly as you want". The test has not time limitation, but the spent time to draw the pictures is recorded. To interpreted examinees function results, Lecks' grading method including 12

principle indexes for intracranial injury arising from Hot and Brisken were used.

These indexes include cycling, overlap pictures, simplifying, fragmentation, retreat, perseveration, Collision or willingness to collision, expressing weakness or inability, problem in arranging, motor inhormony (line vibration), problem in angling and Cohesion (4). After scoring proceeding of the test by guideline criteria, clinical expert can determine whether the examine score is within normative Score in individuals with brain injury or not? Lecks has determine normal range between 0-4 errors and optimized line for organ cutting 5 errors or higher. The reported reliability is totally good for Bender gestalt test. The agreement level between different raters about 12 organic symbols has been reported between 95%-98%, and test–retest reliability in a 3-12 month interval has been 79% for psycho–neurological patients, 66% for Alzheimer patterns 57%-30% for the elderly. The validity to diagnose brain and lack of ingury is 80% (15).

To describe data, descriptive statistics such as percent, frequency, mean, standard deviation (M±SD) and modifications range were used. To analyze errors frequency in gestalts test in two groups, TBIs patients and normal individual, Yates–corrected chi-squared test (for tables 2×2) was used. To determine test reliability internal consistency approach (cronbachs alpha) to calculate the results replicability or inter-raters–reliability, three trained raters devoting single scores to forty protocols of gestalts in TBI patients, intraclass correlation coefficient (ICC) is used to analyze raters scores. Also to characterize reliability, three methods, discriminate validity, criterion validity, construct validity were used. To survey discriminant descriptive method of discriminant validity in both IBI patents and normal persons was used. To survey criterion validity calculation of coordination efficient among scores obtained from gestalt test with MMSE analyzing cognitive function were used, and lastly, to survey construct validity, item–total correlation method was used. All research data were analyzed through SPSS 16 statistical software.

Results:

Over six months period, totally 120 IBI patients (115 men and 5 women) having enterance criterion, were investigated.

Neurologic examination and evaluated psychologically. At the time of IBI occurrence, average age was 31.25±13.60 between 12 to 75 years old and education average 9.49±3.07 and education year range between 2-16. In normal persons, average age was 29.82±34.74 and age range between 12-71 and average education 9.26±3.27 with range 3-16 years. Also, independent results were indicative of no meaning ful difference between normal and IBI subjects in regard to age variable (t=0.81, P=0.42) and education (t=0.55, P=0.58). It means that both groups are identical in the above variable dispersion in addition, in two groups, the individual frequency in equal gender were sampled.

Table 1 shows demographic data in two groups.

Table 2 shows the results from nerves operation examination and also the findings from nervous pictography techniques like CT scan, (MRI in some cases) and skull radiography. Based on the results, 118 patients (98.3%) were afflicted with light TBI and two patients (1.7%) were in medium TBI. In this condition average consciousness for all patients was 14.62±1.71 and the range varied between 12-15 scores of GCS. Also 109 patient based on Glasgow outcome scale (GCS) achieved the ideal improvemen. Visible fractures in skull graphies presented in different kinds and also, the patients showed various brain injury locations in computer tomography scans (CT). To determine the number people who are with positive finding (sub cranial injury) in CT scan, the factors such as brain injury location and total scattered and local injuries were considered. Analyzing cerebral scan from 120 TBI patients indicates that 104 patients have positive finding in CT. The continuous studies characterize that frontal lobe injuries (left, right. two-sided) are more than other cases. Also, the noticeable point was the high rate of various injuries or combined in different place of brain or local injuries which every one devoted 19% of created injuries to him self. Moreover, 35 patients (22%) have been suffered from physical injury with TBI (like orthopedic injuries or injuries

related to general surgery) in different parts of body specially hand and foot.

Table 1. Demographic characteristic in normal and TBI people (n=240)

Avirable		IBI Patien		Normal Individual	
		Frequncy (n)	Percent (%)	Frequncy (n)	Percent (%)
Gender	Men	115	95.2	115	95.2
	Women	5	4.8	5	4.8
Marital status	Snigle	57	47.5	64	3.3
	Married	63	52.5	56	46.7
Education distribution	Elementary	21	17.5	23	19.2
	Secondary	24	36.7	41	34.2
	High school	41	34.2	42	35
	University	14	11.7	14	11.7
Residency	City	63	52.5	75	62.5
	Village	57	47.5	45	37.5
Occupciticnal positin before TBI	Professional	2.5	3.3	4	3.3
	Middle-Manager/Clerk/Staff/Seller	10	8.3	4	3.3
	Industrialists/Repairman/Foreman/ University Student	11	9.2	9	7.5
	Machine Operator/Service-Force/House Wife/Farmer/student	41	34.2	55	45.8
	Simple Worker (Unskilled)	18	15	21	17.5
	Unemployed	13	10.8	5	47.2
	Freelance	24	20	22	18.3

Table 3 shows Yates- corrected Chi-Squared test in which based on all gestalts dozen errors, there is a significant different between TBI patient and normal individual meaning that TBI individual to normal ones had more frequency in dozen errors.

Analyzing discriminant validity of Bender Gestalt test:

The most precise method to analyze discriminant validity is the use of discriminant analysis. To do this, Gestalts test data in both, TBI and normal individuals was analyzed and evaluated by discriminant analysis. The result showed that focal coordinate coefficient is 0.89 indicating a strong relevance between recognition scores in every group (TBI and normal subjects) can separate TBI patients from normal subjects. In other words, this model is able to domen strate 79% (0.89) variable changes dependent on cranial injury.

Table 4, shows the classified result and correction rate of discriminant prediction in both groups.

As, it is observed from the above table, 120 subjects equal with 100% of normal subjects have classified properly. Also, non of them has been classified wrongly in TBI patients group. From TBI patients, 116 subjects equivalence of 96.7% are classified properly in their own group, too in contrast to this group, four IBI patients has been classified wrongly in normal indiduals group. So the exactness of normal individual classification (100%) is more than TBI patients (96.7%).

Totally based on above table results, the exactness of the overall classification is 98.35% for two groups. The rest of the examinees has been classified wrongly (1.65%). It means that Benders test has wrongly classified four IBI patients (3.3%) in the normal individual group.

There fore in can be said that none of the normal subjects has been classified in TBI patients group (classification correction 100%).

Table 2. The result of nerves operation trial and pictography finding of the patients

Variables		Suffered from IBI (n=120)	
		Frequency (n)	Perecent (%)
TBI Intensity	Light(score GCS between 13-15)	118	98.3
	meduim (score GCS beteen 9-12)	2	1.7
Overall inability level after IBI	Idea(desired) improvement (score 5 in GOS)	109	90.8
	medium inability (score 4 in GOS)	11	9.2
The case of skull fracture	Simple (linear)	29	24.2
	Depressed	21	17.5
	Skull	2	1.7
For injuries of brain hemispheres	Left	29	24.2
	Right	42	35
	Two-Sided	26	21.7
Brain injuries location	Right frontal lobe	13	10.8
	Let frontal lobe	13	10.8
	Two-sided frontal lobe	9	7.5
	Right parietal lobe	11	9.2
	Left parietal lobe	5	4.2
	Two-sided parietal lobe	2	1.7
	Right temporal lobe	7	5.8
	Left temporal	7	5.8
	Two-sided temporal lobe	7	5.8
	Occipital lobes	3	2.5
	Various injured location	19	15.8
The cases of local injury	Brain contusion	22	18.3
	On subdural hematomas (EDH)	17	14.2
	Under subdural hematomas (SDH)	7	5.8
	Subarachnoid hemorrhage (SAH)	5	4.2
	Intraventri cular hemorrhage (IVH)	1	0.8
	Intra cerebral hematoma (ICE)	3	2.5
	Various local injuries	19	15.8
The case of scattered injuries	Edema	1	0.8
	Scattered Axoni injury	4	3.3

Table 3. The result of corrected Chi-Square test in TBI and normal people on Bender Gestalts dozen errors

Variable		Patient (Frequency %)	Normal (Frequncey %)	X^2	Significance
Cycling (Span)	**Has**	41 (34.2)	1 (0.8)	46.18	P<0.0001
	Has not	72 (65.8)	119 (99.2)		
Overlap	**Has**	103 (85.8)	22 (18.3)	109.54	P<0.0001
	Has not	17 (14.2)	98 (81.3)		
Simplifying	**Has**	48 (40)	0	60	P<0.0001
	Has not	72 (60)	120 (100)		
Fragmentation	**Has**	40 (33.3)	0	48	P<0.0001
	Has not	80 (66.7)	120 (100)		
Retreat	**Has**	64 (53.3)	0	87.27	P<0.0001
	Has not	56 (47.7)	120 (100)		
Perseveration	**Has**	108 (90)	15 (12.5)	144.24	P<0.0001
	Has not	12 (10)	105 (87.5)		
Collision	**Has**	63 (53.3)	18 (15)	37.74	P<0.0001
	Has not	57 (47.7)	102 (85)		
Inhability	**Has**	7 (5.8)	0	7.21	P<0.007
	Has not	113 (94.2)	120 (100)		
Problem in arrenging	**Has**	87 (72.5)	14 (11.7)	91.10	P<0.0001
	Has not	33 (27.5)	106 (88.3)		
Motor (Movement) inharmang	**Has**	54 (45)	13 (10.8)	34.81	P<0.0001
	Has not	66 (55)	107 (89.2)		
Problem in any angling	**Has**	81 (67.5)	9 (7.5)	92.16	P<0.0001
	Has not	39 (32.5)	111 (92.5)		
Integration	**Has**	114 (95)	22 (18.3)	143.62	P<0.0001
	Has not	6 (5)	98 (81.7)		

Table 4. The classified result and correction rate of discriminant prediction

Groups	Group membership probability		Total
	Normal Individual	**IBI Patients**	
Normal Individual	120	0	120
TBI Patients	4	116	120
Normal Individual	100	0	100
TBI Patients	3.3	96.7	100

Table 5. The mean, the standar deviation and the results of item-total score coordination in Bender's test (n=120)

Item Number	Mean	Standard Deviation	Item-total Score Cooredination	Significance Level
1	13.17	13.14	0.48	P<0.0001
2	12.66	13.65	0.42	P<0.0001
3	13.17	12.77	0.57	P<0.0001
4	13.18	13.04	0.51	P<0.0001
5	12.98	13.55	0.36	P<0.0001
6	12.62	14.52	0.10	P=0.26
7	12.99	14.29	0.16	P=0.076
8	13.36	13.93	0.44	P<0.0001
9	12.79	14.43	0.42	P<0.0001
10	13.06	13.52	0.36	P<0.0001
11	12.84	13.26	0.45	P<0.0001
12	12.56	14.53	0.11	P=0.22

Analyzing stimultaneous validity: to do this, prisons coordination coefficient calculation between total score of benders visual–motor test with MMSE in IBI pattern was used obtaining from a significance level 0.0001 equals -0.53. It means that the higher MMSE results are, the lower the bender's results are. This indicates that simultaneously with more cognitive defect based on MMSE test, motor-visual function in TBI patients in Gestalts will be injured more (in MMSE opposed to Benders test, the higher the individual score is, the better it is. So, getting reverse and negative correlation coefficient is expected).

Analyzing construct validity

Item–total score coordination is measured separately to determine every item with Bender total score if item delete.

Table 5, shows the results. Also the mean, total standard deviation for every item have been presented.

In consideration to table 5, the result of item-total score ranged from 0.10 to 0.57 with the most coordination for simplifying error and the least rate for perseveration error. In addition to the mean and standard deviation (M±SD), all test items 6.75±3.63 were obtained.

To analyze reliability to determine reliability and also, replicability about Benders results among different raters, internal consistency Cronbach's alpha) and intra class correlation coefficient (ICC) were used respectively. The results from internal consistency using Cronbach's alpha were obtained 0.85 for all studied examinees (240 people), 0.43 for 120 TBI patients and 32% for 120 normal people. In TBI patients group Cronbach's alpha ranged 61-66% if item delete with the least rate for simplifying error and the most for collision error. Also, the reliability among three raters (trainer and two trained rates) using intra class correlation coefficient (ICC=0.81) was obtained.

It means that these raters based on lack's scoring approach cover 81% cases, and are correspondendent with each other.

Conclusion:

The objective of this study was to analyze the validity, discriminant and replicability strength of Bender's test in TBI patients. The meaningful difference found between TBI and normal individual sin dozen error indexes (table 3) indicate that TBI patients have higher injured motor-visual function than normal subjects the result of dicrimanant analysis to stady discriminative validity in Bender test showd that this can successfully seperat TBI and normal subjects and it is a reliable tool to differentiat recognition and screen light TBI from normal subjects. The prediction model from discriminant analysis showed that in can correctly classify 100% normal individuals and 96.7% TBI patients and totally 98.3% all individuals. It means that normal individuals are realized 100% healthy by Bender's test, and a TBI person is diagnosed 96.7 with error rate 3.3% (Table 4). So, the data

showed that Bender's test is able to discriminate TBI and normal people, and this result is in harmony with Marsico and Wagner study (15) to compare Pascull-sutell system, Mandich and others to analyze and compare CT scan and cognitive tests like Bender and additionally the individuals collecting grading systems like Hin (1963), lacks (1984) and Marley (1982).

Simultaneous validity of psychological test is shown as correlation coefficient. In this research the correlation coefficient between benders' total score with MMSE total score equaled 0.53% with statistically significance level 0.0001 indicating appropriate validity of Bender test. This negative correlation shows that increasing score in Bender test (weaker motor-visual function), Score individual significantly decrease in MMSE test (weaker cognitive function). Since correlation coefficient between scores of two tests, Bender and MMSE, was obtained more than acceptable criterion 0.40%, simultaneous validity of Bender's test is confirmed.

On the other side, the item-total score coordination was used to analyze construct validity of Bender's test measuring separately the relationship of every dozen errors in Bender's test with total score of the test. The result showed that obtained coefficients vary from 0.10 to 0.57 related respectively to perseveration and simplifying errors. The correlation coefficient for cycling, overlap problem, simplifying, Fragmentation, retreat, inability, problem in arranging , motor in harmony and angling problem errors had high a significant level ($P<0.0001$), but perseveration, collision, integrated errors did not show significant relationship with total score ($P>0.5$).

According to the results, except three recent indexes, others have appropriate intra correlation and express a construct and have an effective role in harmony with other errors and correlation loss among the three indexes with total score needs to develop standardization studies aiming at highlighting construct validity in TBI patients.

To determine Bender's test reliability, internal consistency and inter-raters reliability were used. The results from internal consistency via Cronbach's alpha indicated when Bender's test is implemented for all examinees ($n=240$) present in the research, the internal consistency is high ($\alpha =$ 0.85). It means that the items scales have sufficient homogeneity and consistency. Therefore, it can said that every measured items have similar structure with no prevalence (scatteredness). Cronbach's alpha is the indicator of fitness of a group of items measuring a construct. To have a good and sufficient internal consistency, Cornbach's alpha should be between 0.70 or 0.80 (Bland & Atman) (16). However, Cronbach's alpha coefficient in Bender's test for both groups, TBI and normal individual, is calculated separately with 43% and 32% respectively so that internal consistency rate decreases. One of the reasons can be: reliability coefficient by increasing sample volume and examinees span in the test increase. So that when declining the number of examinees from 240 people to 120, Cronbach's alpha coefficient declined, too. Moreover, because Bender's test opposed to questionnaires and psychological subscales measuring unit construct, it tries to measure different dozen errors by nine different cards. This difference has a role to decrease Cronbach's alpha in measured entity. Also, being examinees with different levels of injury intensity and brain injury type and the time after TBI occurrence have been effective in differentiating responses and decreasing internal consistency of Bender's results.

In addition, to determine reliability between raters, intra class correlation coefficient (ICC) is used. This coefficient can show quantitatively variable reliability and replicability. According to Streiner & Norman (17), internal correlation coefficient above 0.75 is acceptable. In this research the gotten ICC between trainer and two trained persons was calculated 0.81. So Bender's test has a high reliability and replicability strength between different raters. Following recent research lacks and new part (18), the ICC rate for Bender's test reported between 0.95–0.98. Also Bernigon and Scar Dekr (19) in 2 Bender gestalt's test was achieved ICC rate 0.90.

Generally in regard to the results, it can be said that this test has a good discriminant power in discriminant analysis to separate normal and patient ones. The obtained findings from simultaneous validity was significant and showed that along with MMSE test scores react to changing in cognitive function. Also, a desirable

internal correlation is observed in respect to construct validity in nine indexes from twelve error indexes. Internal consistency reliability for all examinees in Bender's test was 0.85 and for TBI, 0.43.

However, ICC coefficient to determine inter-raters reliability was obtained. 81 indicating desirable replicability of the test score between different raters based on lack's grading method.

It can be said about the research limitation that the consecutive sampling is used to provide sample volume in a way that all qualified patients were sampled consecutively. While this typical sampling cannot generalize the findings like random sampling. Also, a factor which may affect individual function in test implementation, is personality factors like behavioral habits and emotional states with no control in the research.

Regarding these limitations, to increase finding generalization in future using multi-central approaches (cover several hospitals), TBI patient sampling is suggested randomly. It is suggested that in these studies, errors pattern in normal individual and other psychiatric disorder such as schizophrenia and moral disorders be analyzed and compared.

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