



Original Article

The Relationship between Working Memory and Confrontation Naming Following Traumatic Brain Injury

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ABSTRACT

Background: The prefrontal cortex is very susceptible to traumatic brain injury (TBI), upon which many cognitive and executive functions including planning, information processing, language, memory, attention, and perception will be impaired. Working memory (WM) is associated with high levels of cognitive processes such as language and naming process communication. In the present study, the correlation between WM and confrontation naming was investigated following TBI.

Methods: The current research was a prescriptive-analytic cross-sectional study examining 20 TBI patients within the age range 18-45 years. The samples were selected from Iran, the city of Mashhad, between 2013 and 2016. The participants with a score 23 or higher in Mini-Mental State Examination (MMSE) were assessed through Persian naming test and sub-tests from the Wechsler Memory Scale. The collected data were analyzed by SPSS16 software.

Results: There was a significant association between subtests of confrontation naming involving 'Correct answers without cue' and WM ($P < 0.05$), 'Wrong answers' and WM ($P < 0.05$), as well as 'Total correct answers' and WM ($P < 0.05$).

Conclusion: The present study indicated modest significant correlations between measures of confrontation naming and WM. These findings provide direction for future studies on the nature of naming deficits following brain injury.

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Introduction

Traumatic Brain Injury (TBI) often results in persistent mental, physical, and behavioral morbidity and mortality, making it one of the most debilitating and distressful traumatic injuries [1-3]. Around 10 million people are affected by it every year worldwide [2, 4]. In industrialized countries, TBI is the main cause of death and chronic disability in those younger than 45 years old [5]. In Iran, it is the second cause of death in traffic accidents [6, 7]. In addition, more than one-half of admitted traumatic Iranian patients suffer head

injury [8, 9]. Accordingly, TBI must be considered as a medical condition which requires accurate diagnosis and outcome prediction [10].

The prefrontal cortex is very susceptible to TBI, upon which many cognitive and executive functions including planning, information processing, language, memory, attention, and perception will be impaired. All such functions are partially dependent on Working Memory for cognitive tasks [12]. WM can be divided into three sub-components: (i) the central executive which acts as a controller program and is vital for skills such as chess playing; and two slave systems called (ii) the visuospatial sketch pad, which manipulates visual images and (iii) the phonological loop, which stores and rehearses speech-based information necessary for the acquisition of both native and second-language vocabulary [13, 14].

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As explained, WM is associated with higher cognitive processes such as language and naming process communication. The naming process is the ability to understand a visual symbol such as a letter, color, etc. and retrieve the name correctly such as picture naming, written words naming, and naming the verbal examination [15]. The naming process is a major system with multiple aspects such as perceptual, cognitive, language, and motor functions [16].

Confrontation naming is a complex process involving several stages. During the first (perceptual) stage, following picture presentation, the pictorial image is analyzed for correct identification of the stimulus. Then, the information is transmitted to the second (semantic) stage, where its semantic representation is activated. In the third (label retrieval) stage, phonological representation corresponding to the semantic representation is retrieved. Finally, there is motor programming stage, where the articulatory sequence is activated, leading to correct naming [17, 18].

In this regard, in previous years, studies have examined the relationship between WM, processing speed, as well as verbal comprehension and FAS performance in individuals who had sustained a TBI. They found that FAS performance was related to verbal intelligence, WM ability, attention, and speed of information processing [19]. Also, concerning the impact of WM and discourse production abilities following closed-head injury, the results revealed a number of modest, significant correlations between sub-tests of the WM and measures of discourse production [20]. On the other hand, research regarding the effect of mild TBI on confrontation naming in adults showed no significant correlations between performance on the higher functioning sub-tests of the SCATBI and naming accuracy in the experimental task for the mild TBI group [18].

Although TBI patients continue their social activities, they have an experience of cognitive problems affecting their performances and have less consciousness on their cognitive skills. Neuropsychological deficits in these patients can cause defective processing of information, attention, and executive performance [21]. The present study aimed at determining the confrontation naming ability and WM capacity of Persian-speaking patients following TBI and the relationship between them. Concerning the importance of this study and availability of limited similar studies, this study can be useful for other specialists as well. Such research in traumatic brain injury patients seem to help create better and more efficient methods of evaluation. Also, the relationship between them can be used to establish new studies.

Methods

The study was prescriptive -analytic cross-sectional with 20 patients suffering TBI (10 men and 10 women) whose ages ranged from 18 to 45 years. All the patients were selected from Mashhad City, Iran. The samples were selected in 2013-2016 and based on the inclusion and exclusion criteria of the study. The study was approved by

the Ethics Committee of Mashhad University of Medical sciences, and the participants consciously signed the letter of consent before the study. The inclusion criteria for the study included: men and women with traumatic brain injuries with mild to moderate degrees of damage (score of 9 or more than 9 based on the Glasgow coma scale (GCS) [22]). Also, severity, type, and location of brain lesions were obtained by computerized tomography (CT) scan and magnetic resonance imaging (MRI). A neurologist reviewed all of the scans independent of the cognitive and linguistic data. Mini-Mental Status Exam (MMSE) [23, 24] was 23 or higher. Subjects aged 18 to 45 years for both sexes. The interval following the brain injury to the time of testing in the study was 1-6 month. Exclusion criteria for participants included documented history of psychiatric illness, pre-existing speech and language disorders such as aphasia, drug abuse, TBI, neurological conditions such as brain tumor, stroke, dementia, and Parkinson. Blind, deaf, and mentally retarded patients were also excluded.

Selection of patients was done by a neurologist based on our inclusion criteria whose main feature was TBI. Demographic, clinical, and paraclinical data of patients were recorded in a questionnaire, including gender, age when injured, education level, ICU and hospitalization duration, etiologic factor, TBI severity, presence of cognitive deficit after TBI, neurosurgical intervention, side of hemisphere lesion, as well as site and type of lesion (Table 1). Nine subjects reported their injuries resulting from motor vehicle accidents, 7 subjects were struck by a motor vehicle while riding a bicycle, and 4 were caused by violent blows to the head. Also, patients' actual cognitive status was evaluated using MMSE, which screens abnormal mental status systematically. Such evaluation covers several domains of cognitive function including orientation, registration, attention and calculation, recall, language, and visual construction. In MMSE, the maximum score is 30, where cognitive impairment is defined by a score of 23 or lower, while considering the patient's grade of education [23, 25]. This scale had previously been standardized in 101 Farsi-Speaking dementia patients with literacy of at least 4 years of formal education. The reliability of this scale was estimated as 0.78 using Cronbach's alpha, and its specificity and sensitivity were calculated as 80% and 90% at cut-off point 23, respectively [26].

In the next stage, sub-tests from the Wechsler Memory Scale (WMS) [27] were administered and used as the measures of WM. The WMS is a clinical measurement of memory with three sub-tests including (a) digit span, which measures immediate recall of a list of numbers, (b) logical memory, which measures immediate and delayed recall of paragraph length information, and (c) associative learning, which measures new learning for a list of paired words presented over three trials. This study only used the digit span.

Finally, Persian picture naming test [28, 29] designed for assessing confrontation naming and differential diagnosis of naming ability in verbal memory, naming aphasia, and Alzheimer's patients was utilized. The

Table 1: Demographic and injury severity characteristics of the patients

Variable	N	Mean	Std. Deviation
Age(years)	20	28.85	9.59
Years of education	20	7.05	3.64
GCS	14	13.47	2.86
Time since injury (months)	20	2.75	1.49
Duration of admission (days)	20	7.37	4.81
PTA duration (days)	8	2.25	1.42
Frontal injury	11	-	-
Parietal injury	7	-	-
Temporal injury	5	-	-
Occipital injury	3	-	-

GCS=Glasgow Coma Scale. PTA=Post Traumatic Amnesia

internal consistency of the test was 0.96 and the test re-test correlation coefficient was 0.87 ($P>0.01$). The correlation between the scores of this battery and naming sub-test of Persian Aphasia Battery (PAB) was 0.58 ($P>0.01$). This test has 50 pictures of different categories, where three groups of animals, nature, and categories of construction were selected. Total linguistic and cognitive examinations were performed at the hospital; the duration of examinations for every participant was approximately 30 minutes, and environmental conditions such as voice, light, and other conditions were suitable for everyone. To describe data, first the quantitative data were expressed as mean and standard deviation, and the qualitative data were assessed as numbers and percentages. Kolmogorov-Smirnov test was used to analyze the normality of the data. The relation of WM with confronting naming was captured using the Pearson's correlation coefficient. The collected data were analyzed by SPSS16 software, with the significance level in all tests set at 0.05.

Results

All participants in this study were equal in terms of gender. The minimum and maximum age of patients was 18 and 45 years respectively and the mean age was 26/7 years. The main demographic and injury severity characteristics of the patient are presented in Table 1. Injury severity characteristics were obtained retrospectively from medical charts which were not

available in a few patients as indicated in Table 1.

Comparisons between groups of men and women based on variables including age, WM, and confronting naming categories are presented in Table 2.

The results of univariate analysis to examine the association between confrontation naming and WM indicated that there was a significant correlation between subtests of confrontation naming involving 'Correct answers without cue' and WM ($r=0.56$, $P=0.01$), 'Wrong answers' and WM ($r=-0.48$, $P=0.03$), as well as 'Total correct answers' and WM ($r=0.62$, $P=0.004$). Pearson correlation coefficients analyzed for the relationship between WM, age, and confronting naming following TBI are provided in Table 3.

Discussion

The purpose of this study was to investigate the relationship between WM and confrontation naming in individuals with TBI. The results indicated modest significant correlations between measures of confronting naming and WM, thus supporting the hypothesis that higher scores on the measures of WM would be associated with better confrontation naming abilities. Indeed, the findings indicated significant correlations between some subtests of confrontation naming and WM. However, there were no significant correlations between WM as well as subtests of confrontation naming and age of the patients.

Table 2: Comparisons between the groups of men and women based on variables

	Sex	N	Mean	Std. Deviation	Std. Error mean
Age	Male	10	27.40	8.54	2.70
	Female	10	30.30	10.80	3.41
Working memory	Male	10	3.20	0.78	0.24
	Female	10	3.50	1.17	0.37
Correct answers without cue (%)	Male	10	84.00	16.24	5.13
	Female	10	91.60	6.97	2.20
Correct answers with semantic cue (%)	Male	10	4.00	2.82	0.89
	Female	10	2.60	2.67	0.84
Correct answers with phonetic cue (%)	Male	10	2.20	2.57	0.81
	Female	10	0.40	0.84	0.26
Wrong answers (%)	Male	10	7.40	10.50	3.32
	Female	10	2.20	2.20	0.69
Without answer (%)	Male	10	2.40	4.59	1.45
	Female	10	3.20	3.55	1.12
Total correct answers (%)	Male	10	90.20	12.12	3.83
	Female	10	94.60	5.66	1.79

Table 3: Pearson correlation coefficient between age, WM, and confrontation naming

		Age	Working memory
Working memory	Correlation coefficient	-0.089	-
	Sig. (2-tailed)	0.710	-
	N	20	-
Correct answers without cue	correlation coefficient	-0.151	0.566
	Sig. (2-tailed)	0.524	0.013*
	N	20	20
Correct answers with semantic cue	correlation coefficient	0.152	-0.314
	Sig. (2-tailed)	0.523	0.178
	N	20	20
Correct answers with phonetic cue	correlation coefficient	-0.153	-0.181
	Sig. (2-tailed)	0.519	0.444
	N	20	20
Wrong answers	correlation coefficient	0.200	-0.484
	Sig. (2-tailed)	0.398	0.031*
	N	20	20
Without answer	correlation coefficient	0.243	-0.399
	Sig. (2-tailed)	0.301	0.082
	N	20	20
Total correct answers	correlation coefficient	-0.205	0.620
	Sig. (2-tailed)	0.385	0.004*
	N	20	20

*P-value<0.05

This is the first study in Iran to report a relationship between WM and confrontation naming in patients following TBI. The results in the present study were similar to relationships reported in previous studies [19, 20]. In Robyn et al. (2007), WM performance was related to verbal intelligence, attention, and speed of information processing. Also, Youse and Coelho, 2005 reported significant correlations between sub-tests of the WM and measures of discourse production. In both studies, the same test was for measuring WM as with the present study. Sub-tests from the Wechsler Memory Scale involve the memory for lists of numbers or words. As such, they determine only storage capacity and do not take into account the dual role of processing and storage often thought to be performed by WM [30]. In this regard, our findings were concordant with Youse and Coelho (2005) and Robyn et al. (2007) results.

In Barrow et al. (2006), the mild TBI group displayed significantly slower response latencies and reduced response accuracy for confrontation naming than the control groups. In most cases, the experimental variables designed to enhance cognitive load did not differentially affect the performance of the mild TBI group. That is, both groups responded with similar response profiles, and the results were inconsistent with the present study findings. This contradiction could be due to differences in intensity of brain injury, measures, language, etc. In this research, for evaluating confrontation naming abilities, Persian Picture Naming Battery was used which is the standard test in Iran [7, 28, 29]. Persian Picture Naming Battery has appropriate validity and reliability as a clinical tool to measure naming deficits in Persian speaking aphasic and Alzheimer patients. It can also differentiate different patterns of naming deficits in aphasics and Alzheimer patients using phonological and semantic cueing. Concerning the severity and type of disorder, based on total correct answers up to 75%,

the severity of disorder is mild, between 50%-75% it is moderate, and severe type is associated with less than 50%, which have been incongruent with those of Barrow et al. (2006).

Limitations

A few limitations should be acknowledged. The first was selection criteria. The sample size was small and further investigations with a larger sample size are warranted. Indeed, patients in the Good Recovery and in the Severe Disability categories are less likely to be referred to such programs. Whether the present findings apply to patients with less severe injury or in contrast with very severe residual disability remains to be investigated. Also, the nature of the task related to WM was presumably not complex enough to provoke a large WM deficit. The lack of control group in the study was one of the other limitations of the study.

Conclusion

The results of this study suggested a relationship between WM ability and confrontation naming in individuals with TBI. The results indicated data that TBI can affect the confrontation naming and the WM. In addition, it can be stated that cognitive problems (attention, memory, and allocation of processing resources) may be involved in the difficulties experienced by those with TBI in everyday communications. In healthcare planning, to increase the quality of the communication of people with TBI, it seems that more attention should be paid to WM and language issues. These findings are encouraging in that they provide researchers with direction for future studies on the nature of naming deficits following brain injury. A better understanding of the underlying nature of naming processes will facilitate development of more sensitive assessments and treatment procedures for the

communicative impairments of individuals with TBI. Also, our findings suggested the need for further research into the role of WM in the process of naming from TBI and the efficacy of language therapy.

Conflict of interest: None declared.

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