

Neuropsychological Double Dissociation between Linguistic Levels: Clinical Linguistic Evidence from Iranian Aphasic Patients

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Article info:

Received: 22 January 2012
 First Revision: 30 January 2012
 Accepted: 10 June 2012

Key Words:

Clinical Linguistic,
 Aphasia,
 Persian,
 Azari,
 Badrudi,
 Language-Specific
 Impairment,
 Double Dissociation.

A B S T R A C T

Introduction: In this paper we report on clinical linguistic applications of several versions of the Bilingual Aphasia Test (BAT) and the Persian Aphasia Battery (PAB) developed to assess patterns of recovery and language impairments in monolingual and bilingual aphasics with different clinical histories living in Iran.

Methods: The participants are adult monolingual native speakers of Persian or polyglot speakers whose second or third language is one or two of the local languages, local dialects and/or English or German among the educated multilingual population. The recovery pattern and level of language impairments of each patient were assessed based on his or her clinical linguistic profile as well as analysis of the connected speech samples.

Results: The linguistic profiles of monolinguals and different recovery patterns of the bilingual patients support the idea that language-specific impairments correspond to the structural properties of Persian language. The results also support incidence of selective impairments of different language skills in patients with the same lesion site. As an incidence of double dissociation the data indicated that Broca's and Wernicke's aphasics behaved differently. The mean syntactic comprehension scores of Broca's patients were four times higher than that of the Wernicke's patients (4.25 vs. 0). On the contrary Wernicke's patients mean MLU was three times higher than that of Broca's aphasics (6.9 vs. 2.30).

Discussion: The clinical linguistic evidence from a heterogeneous group of case studies using the BAT and the PAB assessing Persian aphasics support dissociation of impairment between different levels of language, spoken and written skills. The data from patients with different lesion sites could explain the idea of under specification of functional anatomy of the classical brain-language model.

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Introduction

Languages Spoken in Iran

IIran as a polyglot country has the population of supposedly 70 millions. The official and educational language of the country is Persian (Farsi) - an Indo-European language. However Farsi is not the only language spoken in Iran; Azari, a member of the agglutinated family of languages in which affixes are attached to the root of a word, is the second most frequently spoken language with more than 10 million speakers, Kurdish is a member of Western Iranian languages and consists of several dialects with a phonology and morphology system different from that of contemporary Persian. Arabic, Turkeman, Baluchi, Armenian and Asurian are other local languages spoken by different ethnic groups living in different parts of Iran. There are also two main dialects of Persian, Gilaki and Mazandarani, spoken along the Caspian coast, and several other local Iranian dialects spoken by the population in central and southern parts of Iran (Katzner, 2002).

Clinical Applications of the BAT

The history of clinical applications of the BAT (Paradis et al., 1987) in Iran goes back to the 1980s when Persian version of the BAT (the Bilingual Aphasia Test) was made available as the first multilingual clinical and experimental aphasia test. Later new versions of the BAT were developed for other languages including Azari, Kurdish and Armenian. Since then, many Persian speaking patients with aphasia have been assessed in clinical settings for therapeutic purposes and some of these cases have been reported for the first time at international conferences (e.g. Nilipour, 2008) or published in Iranian or international English journals (e.g. Nilipour, 1988; 1989; Nilipour & Ashayeri, 1989; Nilipour, 2000). The BAT and the PAB (Persian Aphasia Battery, Nilipour, 1994) have also been implemented as a research tool in some doctoral (e.g. Raghidoost, 1999) or master theses (e.g. Rezaei, 2008) in different institutions inside or outside of Iran.

The major aim of this paper is to give a brief description of major aphasiological studies and clinical linguistics applications of versions of the BAT and the PAB and to attempt to depict the language specific characteristics of agrammatism and recovery pattern of language skills in patients with different lesion sites. It is also an attempt to show the general trend of double dissociation of aphasic deficits among two major types of aphasia (fluent vs. non-fluent). With these aims in mind, we first

present a very short description of the aphasic cases published previously in English international journals (Nilipour, 1988, 1989; Nilipour & Ashayeri, 1989; Nilipour, 2000; Nilipour & Raghidoost, 2001). In addition to the published case studies reported here, four groups of heterogeneous clinical case studies by different clinicians using the BAT or the PAB either for therapeutic or research purposes are reported here for the first time.

Published Cases

All aphasic data reported here are based on systematic assessments using Persian, Azari, English, and German versions of the BAT. The reported cases are either monolingual or multilingual. They are of different etiologies; (cerebrovascular accident (CVA) in patient PA, trauma in patients AS, HB, MN and arteriovenous malformation (AVM) in patient TB.

Monolingual Participants with Aphasia

Two monolingual individuals (HB and MN) developed aphasia as a result of shrapnel trauma during the Iraq-Iran war (Nilipour, 2000). The general background information on both patients and the control participant are given in Table 1. Both individuals were assessed with the standard short version (Paradis & Libben, 1987) of the Persian BAT during the chronic phase. Both patients were diagnosed with Broca's aphasia and satisfied the CLAS I clinical standards for agrammatism: slow and halting speech, short and/or fragmentary sentences, and limited use of the syntactic and morphological resources of their native language (Nilipour, 2000; Menn & Obler, 1990). The grammatical violations and deficits of HB and MN are matched with control data based on the descriptive framework of the Cross-Language Aphasia Study (Menn & Obler, 1990: ch. 2) and may be used for cross-language comparison purposes.

The performance of both patients on the BAT and their speech deficits are compared with matched control data. Their most salient agrammatic features are briefly reviewed. For details of each case, consult Nilipour (2000).

Case HB

Based on his general linguistic profile on the BAT, HB's comprehension and production were both impaired, but his comprehension was relatively better preserved than his expression. His utterances were short, and his grammar was very restricted and simple: All his utterances were single clauses, with or without a lexical verb.

Table 1. Background information on aphasics and control subject

Background Information	HB	MN	AM (control)
Age	20	21	17
Sex	M	M	M
Occupation	Student	Student	Student
Years Of Education	10	11	11
Native Language	Persian	Persian	Persian
Handedness	Right	Right	Right
Etiology	Trauma	Trauma	—
Lesion Side	L	L	—
Lesion Site	Fronto-temporal	Parietal	—
Post-Onset Assessment	20 months	10 months	—
Aphasia Type	Broca's	Broca's	—

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Omissions and substitutions occurred across all speech samples, but there were three times as many omissions as substitutions (86 vs. 30). About 70% of word deletion errors involved function words, and 74% of the deleted content words were lexical verbs. Most lexical verbs in different written contexts were replaced by the low-content verb /ast/ 'is', a third person connective verb. HB omitted over 58% of grammatical morphemes in the required contexts, with about 35% used correctly and the remaining 7% incorrectly.

Compared with the control participant, HB's performance is indicative of his poor access to lexical categories and complex syntax (cf. 4.2 vs. 8.6 for MLU and 185 vs. 377 for total words). His limited number of required contexts for all grammatical categories is further evidence of his simple syntax (144 vs. 328). He had especially poor access to prepositions and the morpheme /-e/ as a linking morpheme in complex NP structures, and he also made limited use of derivational and inflectional morphemes, which is evidence of his avoidance of contexts that require grammatical categories.

Case MN

Based on the results on the Persian version of the BAT, MN's comprehension was much better preserved than his expression. Function words were more vulnerable to deletion than content words: 73% of the missing words in his connected speech samples were function words. Another major feature of MN's speech impairment was the use of the infinitive (a poly-morphemic uninflected form)

in lieu of the contextually required inflected form of the verb in the written mode.

A comparison of MN's linguistic performance and that of the control participant in parallel tasks indicates that production of short, simple sentences (MLU 4.4 vs. 6.7) resulted from his poor access to lexical categories and the right function words (10 vs. 19).

HB and MN's clinical linguistic data suggested that in spite of different lesion sites, both exhibited simplified syntax and morphological errors and some types of breakdown of the VP (Verbal Phrase) as manifested by deletion and/or substitution, and different degrees of NP disruptions, mostly manifested by the deletion of preposed and/or postposed object particles (/be/ and /râ/) and prepositions. HB and MN's linguistic deficits may be summarized as general agrammatic symptoms of Broca's aphasia, accompanied by specific features such as substitution of the third person of the verb /budan/ 'to be' as a filler verb for all kinds of verbs including transitive verbs by HB and substitution of the polymorphemic infinitive for the contextually proper inflected form of different kinds of verb by MN in the written mode.

Multilingual Aphasics

From among the bilingual Persian aphasic population reported in the literature, fourteen Persian bilingual or trilingual patients with symptoms subsequent to either stroke, trauma, AVM or closed head injury have been previously documented in the literature using relevant versions of the BAT (for details see Nilipour, 1988). These patients consisted of a heterogeneous population with respect to age, context of acquisition, context of use, degree of fluency in each of their languages and the linguistic distance between them. The languages involved were Persian as the first and Azari, Armanian, English, and German as the second or third language. They also differed with respect to age at aphasia onset, months post-onset at time of language assessment, etiology, site and size of lesion and consequently, with respect to major aphasic symptoms.

With respect to patterns of recovery, five different patterns were observed. In the three cases of differential

recovery, the best recovered language was the language of the environment which was also the patient's dominant language. The two cases of language mixing were found in patients with posterior brain damage. The case of antagonistic recovery in a trilingual individual (Nilipour and Ashayeri, 1989) involved languages (Persian, German and English) that were structurally distant but equally fluent at the time of injury.

Two of the previously published cases (PA & AS) have been extensively reported for the pattern of recovery (AS) and the task-specific agrammatic impairments (PA), as indicated by assessment with the BAT, including the post-test analysis (Paradis & Libben, 1987) of the connected speech samples elicited from each client during the assessment procedures.

A summary of the characteristics of both patients are given below. Their general background information is given in table 2. (For detailed information on the general linguistic performance, deficits and etiology of PA see Nilipour (1989) and for AS see (Nilipour and Ashayeri, 1989).

Table 2. Background information on two polyglot patients

Background	PA	AS
Age	48	49
Sex	F	M
Occupation	Clerk	Businessman
Years Of Education	15	8
Native Language	Persian	Persian
Other languages	English	German & English
Handedness	R	R
Etiology	CVA	Trauma
Lesion Side	L	L
Lesion Site	Fronto-temporal	Fronto-Temporal
Post-Onset Assessment	48 months	18 months
Aphasia Type	Conduction	Broca's

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Case PA

PA's performance was relatively similar in Persian and English. She suffered from impaired repetition (at the sentence level) and limited, slow oral production. Consequently, she was diagnosed with conduction aphasia

(for further details see Nilipour, 1989 and Nilipour and Paradis, 1995). Her specific clinical linguistic violations were task-specific (i.e. Repetition & Reading aloud) in both languages, manifested at the sentence level in two tasks of the BAT (Sentence Repetition and Sentence Reading aloud) consisting of ten sentences of different syntactic constructions and complexities in tasks equivalent in both languages. PA's grammatical violations had different manifestations that were compatible with structural properties of each language. In English, all grammatical violations were omission of grammatical morphemes in obligatory contexts and the number of omissions correlated with the complexity of the sentence. In the same task, her Persian linguistic violations presented a different clinical picture. The violations in Persian were more varied and of different types: omission of grammatical particles (12 cases), substitutions (3 cases) and reconstruction of inflectional form of the verb in the reading task (10 cases). In general, there were more omissions than substitutions of free grammatical morphemes. Bound morphemes and inflectional endings were more vulnerable to substitution.

Case AS

AS, a trilingual patient, was systematically and comprehensively assessed in each of his three languages with three versions of the BAT. With respect to pattern of recovery, he exhibited an alternating antagonistic recovery between two languages (Persian and German) over a period of one month, followed by the recovery of the third language (English) only when the use of the other two languages was finally under voluntary control (for details see Nilipour and Ashayeri, 1989).

The clinical picture of AS's performance can be summarized as fluent speech, poor comprehension, relatively good repetition and impaired writing, which is compatible with a diagnosis of transcortical sensory aphasia. AS's lexical errors were characterized by substitution of different parts of

compound verbs in Persian and evidence of mixing morphemes of the three languages in the same phrase. The details of AS's residual capacities and deficits as well as his patterns of language recovery during the acute period after the lesion in Persian, German and English (Paradis & Libben, 1987) are provided in Nilipour and Ashayeri (1989) and Nilipour and Paradis (1995).

New Clinical Linguistics Studies

Currently, versions of the BAT are used as a clinical tool in some speech therapy clinics of the country to evaluate both monolingual and bilingual adult clients who are referred for language therapy due to brain damage. The results of assessments are used to determine aphasia type as well as therapy procedures. The BAT and PAB are also used by some graduate students (See

Rezaei, 2005) or researchers (e. g. Nilipour et al., 2010) as a tool for clinical and neurolinguistic studies. Available data based on clinical applications of some versions of the batteries are presented here: (1) Three monolingual Persian speakers (ER, SR and MH); (2) Three Bilingual Azari-Persian speakers (TM, BK and AJ); (3) Five Badrudi-Persian speakers (BA, GR, HA, IK and MK); (4) Eleven monolingual CVA Persian aphasic speakers (see Table 4). The general demographic and

Table 3. Background information on 11 new patients

Characteristics	ER	SR	MH	TM	BK	AJ	BA	GR	AL	IK	MK
Age	39	40	46	36	83	76	75	74	58	43	70
Sex	F	F	M	F	M	M	M	M	F	F	M
Occup.	Teach	Sec	C.S.	H.W.	clerk	business	Farmer	Farmer	H. W.	H.W.	farmer
Educ.	17	14	14	7	16	6	0	0	0	0	0
Native L.	PER	PER	PER	AZ	AZ	PER	BAD	BAD	BAD	BAD	BAD
Other L.	--	--	--	FAR	FAR	AZ	FAR	FAR	FAR	FAR	FAR
Handed.	R	R	R	R	R	R	R	R	R	R	R
Etiology	CVA	CVA	TR	CVA	CVA	CVA	CVA	CVA	CVA	CVA	CVA
Lesion S.	L	L	L	L	L	L	L	L	L	L	L
Lesion T-P	T-P	T-P	T-P	T-P	T-P	F-T	P-Cereb	F-P	F-P	T-P	F-P
Post-on 6	6	7	2	22	6	1	4	84	60	10	96
Aphasia Type*	CON	WER	CON	BROC	BROC	WER	BROC	BROC	BROC	BROC	BROC

*Con=conduction; BROC=Broca; WER=Werneke

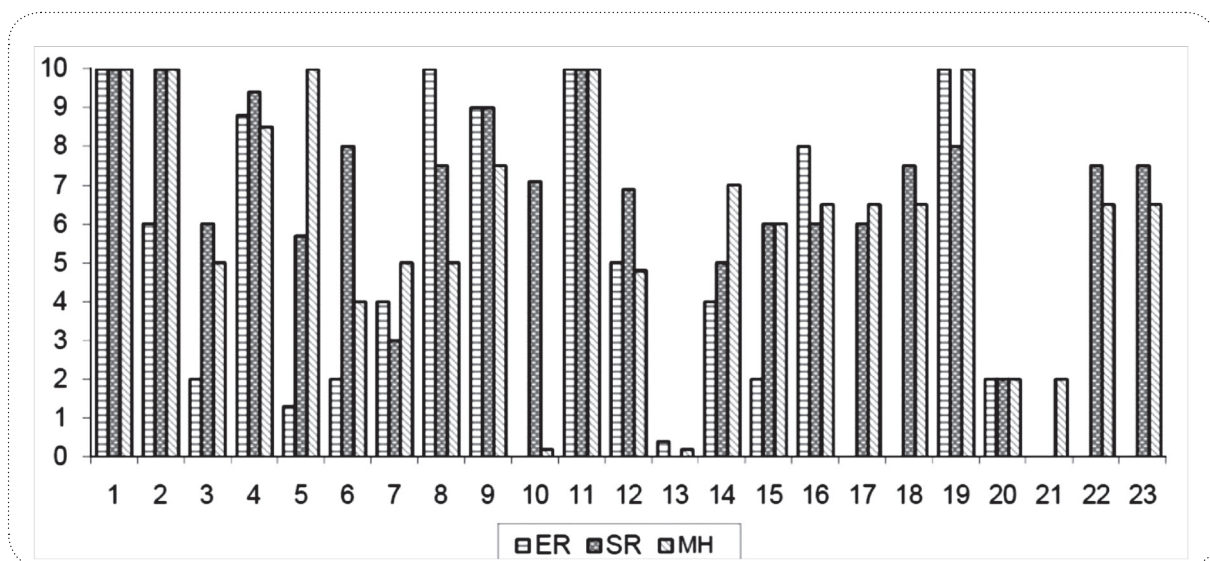
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background information of the participants in the first three studies is presented in Table 3.

As can be seen in Table 3, five of the participants are female and six are male. They range from 36 to 83 years of age with an average of 58. They all suffered a CVA except for one trauma case (MH). The participants were right-handed and the lesion was situated in the left hemisphere, but the site of lesion is not the same in all participants. There were three monolingual speakers (ER, SR and MH), two bilinguals (TM, BK) with a left Temporo-Parietal lesion, and one bilingual participant with a fronto-temporal lesion (AJ). The Badrudi and Persian aphasic group suffered from a left fronto-temporal CVA. In what follows the clinical linguistic profile of each group will be briefly discussed.

Monolingual Patients

The three monolingual Persian speakers (ER, SR and MH) were part of a larger study the aim of which was to determine their language rehabilitation needs as they relate to etiology and lesion site (see Nilipour et al., 2010). All three were within the same age range (39 to 46), with 14 to 17 years of education and a left temporo-parietal lesion. Two participants (ER, SR) suffered a CVA and MH's a trauma. They were initially assessed using the Persian version of the BAT. Based on the results of the BAT during the chronic period, they had different profiles (see Figure 1). According to their general profile comprehension skills recovered relatively better than production. However, their linguistic behavior differed significantly in Sentence Repetition and Reading tasks. ER and MH had different etiologies but both suffered significantly in Sentence Repetition task as compared to ER's performance (0 vs.75%). Based on this diagnostic feature, ER and MH were diagnosed as conduction



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Figure 1. ER, SR & MH's Profiles on BAT. 1. Pointing; 2. Simple commands; 3. Semi-complex commands; 4. Verbal auditory discrimination; 5. Syntactic comprehension; 6. Synonyms; 7. Antonyms; 8. Repetition (words); 9. Lexical decision; 10. Repetition (sentences); 11. Series; 12. Naming; 13. Sentence construction; 14. Semantic opposites; 15. Listening comprehension; 16. Oral reading (words); 17. Oral reading (sentences); 18. Reading comprehension (paragraph); 19. Copying; 20. Dictation (words); 21. Dictation (sentences); 22. Reading comprehension (words); 23. Reading comprehension (sentences).

aphasia. ER's scores on Oral and Silent Reading skills were also significantly lower than MH and SR (0 vs. 65 to 75). The general performance of SR was indicative of mild Wernicke's aphasia. (see Figure 1). The results from the 3 patients indicated that although they had the same lesion site but with respect to recovery patterns and aphasic deficits they behaved differently.

Based on the performance of each subject on the subtests of BAT indicated in Figure 1, relevant therapeutic procedures were recommended. Reportedly, ER and MH received stimulation of relevant failed production tasks, while SR received relevant comprehension tasks using picture matching stimuli of the BAT.

Azari-Persian Bilingual Participants

One of the three Persian-Azari bilingual patients (BK) met the criteria of the study and was able to answer both Azari and Persian versions of BAT (Table 3). BK's general linguistic profiles in Persian and Azari indicated that both languages were severely impaired (scored zero in 9 tasks in Persian and 8 in Azari). In both languages written tasks were more severely impaired than in the spoken tasks. Based on the results of his general recovery, he was diagnosed with Broca's aphasia and therapeutic services were provided in Azari using picture matching stimuli of the BAT.

TM's linguistic Profile in Persian indicated that her performance in spoken language skills were much better than in her written performance. Since her general recovery on the comprehension tasks was better than her production she was diagnosed as Broca's aphasia and therapeutic procedures were provided only in Persian upon her demand.

AJ's linguistic profile in Persian indicated that his scores in comprehension skills were 50% to 70% higher than production skills in five tasks. His performance in reading is also much better than his writing. Repetition, Oral reading, Copying and Reading comprehension were fully recovered (100%) on all tasks. Based on his general profile he was identified as exhibiting Wernicke's aphasia and therapy was provided using picture matching tasks of the Persian version of the BAT.

Based on the observed deficits two patients (TM & BK) with temporo-parietal lesion were diagnosed as Broca's aphasic while the patient with fronto-temporal lesion (AJ) was diagnosed as Wernicke's aphasic.

Badrudi Patients

The Badrudi study consisted of five illiterate chronic CVA patients who were referred by the Welfare Office to the urban therapist (S.A.B.) for rehabilitation services

through home visits in their village (Badrud). The clients were two female and three male aphasics from the same village. They spoke both Persian and Badrudi, a member of the central group of Iranian dialects spoken in Badrud in the vicinity of Kashan. The dialect contains some morphological and phonological differences with contemporary Persian. The therapist who was a native speaker of the dialect assessed their recovery in both Badrudi and Persian before any rehabilitation procedure. She decided to develop an experimental Badrudi version of the BAT under the supervision of the first and second authors (R.N. and H.R.) and assessed the patients on both the Persian and Badrudi short versions of the BAT. She was also able to collect some samples of connected speech from two of the patients (BA and HA). Based on the results of the assessment on both versions of the BAT, the therapist was able to identify the relative severity and recovery pattern of Persian and Badrudi in each patient.

BA's profiles in Persian and Badrudi indicated that his general performance in Persian was somewhat better than Badrudi (total failure in 3 tasks in Badrudi vs. one in Persian). In 7 tasks his performance in Persian was 80% to 100% better than Badrudi (his native and currently used language). The general recovery pattern indicated that his comprehension in both Persian and Badrudi were better than his performance. Based on his connected speech samples he had an MLU of 4.18 in Persian and 3.81 in Badrudi. His Type-Token ratio (TTR) in Persian was higher than in Badrudi (0.71 vs. 0.57). His general profile suggests Broca's aphasia in both Persian and Badrudi.

GR's linguistic profiles indicate that his linguistic skills were severely impaired in both Badrudi and Persian (total failure in 10 tasks vs. 9). Three comprehension tasks reached criterion in Persian but only one in Badrudi. His general profile indicated that his comprehension in both Persian and Badrudi were better than his production. He was diagnosed as having Broca's aphasia.

AL's linguistic profiles indicated that her general recovery in Persian was better than in Badrudi (6 tasks 80% to 100% accurate performance vs. 3; and scored zero in 6 vs. 3). Her comprehension in Persian was fairly better than in Badrudi. The general pattern is a relatively differential recovery with Persian as the better recovered language. Based on her connected speech samples, her MLU in Persian was lower than Badrudi (3.08 vs. 4.14). But her TRT in Persian was higher than in Badrudi (0.88. vs. 0.72). She was diagnosed with Broca's aphasia.

IK was assessed with the BAT only in Persian due to her medications during several home visits. Her general profile in Persian indicated that her comprehension was better than her production. Her only production score was 60% on series and was diagnosed as having severe Broca's aphasia in Persian.

MK's linguistic profiles were collected both in Persian and Badrudi. His general performance was similar in both languages, indicating a parallel recovery pattern. His performance in 5 comprehension tasks was similar in both Persian and Badrudi (unable to perform 9 tasks). The severity of impairment was relatively the same in both Persian and Badrudi and he was diagnosed with severe Broca's aphasia. Availability of the BAT in Persian and development of the Badrudi version helped the local therapist to assess each of the 5 chronic CVA patients during her home visits. Measuring the severity of impairments in both Persian and Badrudi in the same person using the same measuring tool helped the therapist to provide the choice of language therapy either in Persian or Badrudi in each individual.

Based on results all Badrudi patients were diagnosed as Broca's aphasics but they did not suffer from the same lesion site. Three patients were reported to suffer from a Fronto-parietal lesion and two patients from a temporo-parietal lesion.

Broca's and Wernicke's Group

This group of subjects consists of 11 monolingual Persian speaking CVA patients who participated in the study (Rezai, 2008). Their background information is given in Table 4. There were seven male and four female right-handed educated (mean 12) native speakers of Persian with an average age of 50 suffering from from a left side CVA with six lesions in FTP, three in FT and two in TP. The site of each patient's lesion was determined by a neurologist. The participants were examined at a minimum of three and a maximum of six months post-on-set (see Table 4).

They were initially assessed using the Persian Aphasia Battery (Nilipour, 1994) to determine whether they present with fluent or non-fluent aphasia. Based on the results of the first assessment, nine were diagnosed as suffering from Broca's (non-fluent) aphasia and two (ST and HA) as Wernicke's (fluent) aphasia (see Table 5).

In the second phase of assessment, the two groups participated in a post test study to compare the syntactic comprehension of the two groups using the Syntactic

Table 4. Background information on Broca's and Wernicke's group

Background	GB	GM	PD	ST	MM	MS	HZ	AS	AR	HA	LA
Age	36	45	57	60	24	53	42	38	56	72	65
Sex	M	M	F	M	M	F	M	F	M	M	F
Education	6	12	12	12	12	15	15	12	15	12	12
Native L.	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER
Handedness	R	R	R	R	R	R	R	R	R	R	R
Etiology	CVA	CVA	CVA	CVA	CVA	CVA	CVA	CVA	CVA	CVA	CVA
Post-Onset (months)	3	4	6	3	5	3	4	6	5	4	6
Lesion Side	L	L	L	L	L	L	L	L	L	L	L
Lesion Site*	F- T- P*	F- T- P	F- T- P	T- P	F- P	F- P	F- P	F- T- P	F- T- P	T- P	F- T- P
Aphasia	BROC	BROC	BROC	WER	BROC	BROC	BROC	BROC	BROC	WER	BROC

*T-P = Temporoparietal; F-P = Frontoparietal; T = Temporal; F = Frontal

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Section of the BAT (items 66 to 152), and MLU (mean length of utterance) and TTR (type token ratio) of their connected speech samples. Since the Syntactic section of the BAT is comprised of a range of sentences with different syntactic variation and complexity, the task

can be used as an index of severity of syntactic impairment of each patient.

The syntactic comprehension score of each patient was determined by the number of correct answers given

Table 5. Comparison of syntactic comprehension scores and MLU of Broca's and Wernicke's Aphasics

Patients			MLU		TTR	
	Aphasia	Syntac. comp	Spon. Sp.	Des. Sp.	Spon. Sp.	Des. Sp.
GB	Broca's	5.30	3.4	3.5	0.31	0.42
GM	Broca's	3.17	2.6	2.9	0.38	0.34
PD	Broca's	4.81	2.2	2.5	0.26	.028
ST	Wernicke's	0	6.7	7.8	0.31	0.38
MM	Broca's	4.12	3.6	3.2	0.31	0.44
MS	Broca's	6.17	2.1	2.4	0.33	0.38
HZ	Broca's	8.27	3.6	3.9	0.34	0.45
AS	Broca's	3.35	2.8	3.3	0.31	0.44
AR	Broca's	3	2.5	2.6	0.28	0.27
HA	Wernicke's	0	7.1	7.7	0.39	0.42
LA	Broca's	4.3	2.6	2.3	0.29	0.35

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by each patient to the Syntactic Comprehension stimuli (items 66 to 152) of the short version of the BAT. The MLU and TTR of each patient were determined based on the analysis of two connected speech samples

(spontaneous and descriptive) collected from each patient. The results of syntactic comprehension scores and MLU and TTR are given in Table 5.

As can be seen from the figures in Table 5, the overall syntactic comprehension scores of each Broca's patient

are higher than the Wernicke's patients (maximum 8.27 for HZ and minimum 3 for HA as Broca's patients and zero for Wernicke's patients). On the contrary, the Wernicke's patients MLU scores are higher than the Broca's patients. The Broca's patients gained a significantly lower MLU (3.6 vs. 7.8) than the Wernicke's patients (see Table 5).

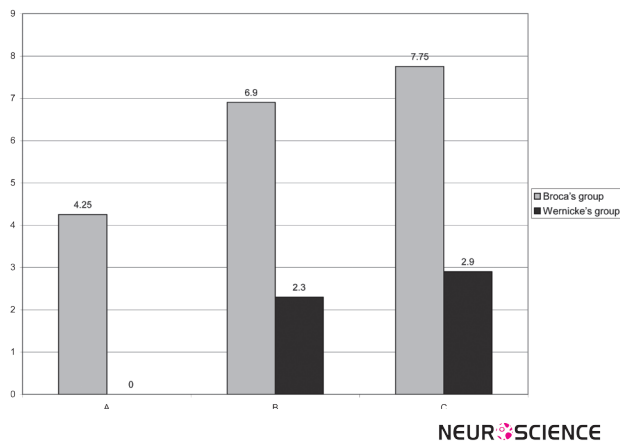


Figure 2. Comparison of mean syntactic comprehension scores & MLU of Broca's and Wernicke's patients
A= mean syntactic comprehension scores;
B= mean MLU in spontaneous speech;
C= mean MLU in descriptive speech.

The mean syntactic comprehension scores and MLU of the Broca's and the Wernicke's patients are compared in Figure 2. As the figures indicate the Broca's patients' comprehension mean score is four times higher than the Wernicke's patients (4 vs. 0). On the contrary the Wernicke's patients MLU in both connected speech samples (descriptive and spontaneous) were three times higher than the Broca's aphasics (6.9 vs. 2.30 for spontaneous speech and 7.75 vs. 2.9 for descriptive speech) (see Figure 2).

As can be seen from Figure 2, the mean syntactic comprehension scores of participants with Broca's aphasia were four times higher than that of the Wernicke's patients (4.25 vs. 0). On the contrary the Wernicke's patients mean MLU was three times higher than that of the participants with Broca's aphasia (6.9 vs. 2.30 for spontaneous speech and 7.75 vs. 2.9 for descriptive speech samples). Based on the results, the present clinical linguistic behavior of the Broca's and Wernicke's patients support Pulvermuller's proposed neuropsychological double dissociation in the behavior of Broca's and Wer-

nicke's patients after focal lesions (Pulvermuller, 2004, pp.66-73). The two syntactic measures (mean syntactic comprehension score as a measure of syntactic comprehension and MLU as a measure of syntactic production) are suggestive of a neuropsychological double dissociation

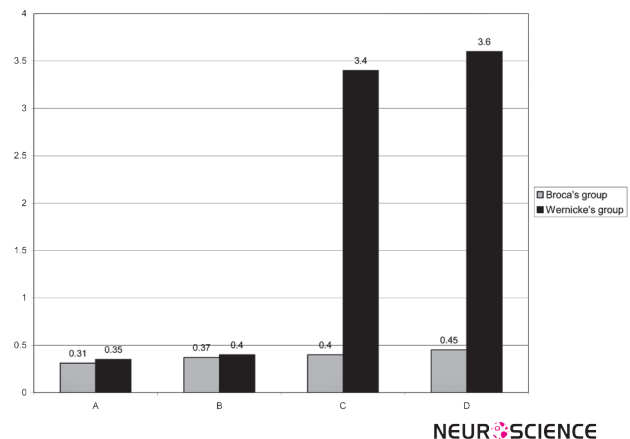


Figure 3. Comparison of mean TTR and function words in Broca's and Wernicke's patients connected speech samples.
A= mean TTR score in spontaneous speech,
B= mean TTR score in descriptive speech,
C= Mean function words in spontaneous speech, D = Mean function words in descriptive speech

tion in which one linguistic feature (syntax) is selectively damaged in one group of aphasics.

At the lexical level, there seems to be a neuropsychological double dissociation in the behavior of Wernicke's and Broca's aphasics. Wernicke's gained a higher TTR as compared to the Broca's group in both speech samples (.35 & .4 vs. .31 & .37) which suggests a richer vocabulary for Wernicke's. On the contrary Broca's aphasics used many more function words than the Wernicke's in their connected speech samples (Figure 3).

As Pulvermuller has suggested that there is a double dissociation between agrammatism (function word impairment, perisylvian lesion) and anomia (content word impairment, extrasyylvian lesion). He has also suggested that other word category dissociations may well be explained along the same line (Pulvermuller, 1995 & 2004, P.73). The clinical linguistic data presented from the Broca's and Wernicke's aphasic patients in Rezae's study are in line with Pulvermuller's double dissociation hypothesis.

Conclusion

The availability of different versions of the BAT and the PAB in Iran as reported in this paper makes it possible to discuss a variety of clinical linguistic data concerning different groups of patients with different lesion sites which are either (1) monolinguals and/or bilinguals whose native language is one or two of the languages spoken in Iran, or (2) bilingual speakers whose mother tongue is Persian, and their second or third language is one or two of the local languages or dialects and/or (3) Those whose second language is English or German as the language of higher education among the educated multilingual population.

The overall data from this heterogeneous group of Persian speaking monolingual as well as bilingual aphasics discussed here suggest that different language-specific agrammatic features are consequent to focal lesions in chronic patients with aphasia. The presented language-specific features correspond to the structure of the Persian language. One major language-specific feature of Persian indicated in the data is the multifaceted vulnerability of VP as manifested in different tasks and in both spontaneous spoken and written samples as observed in the clinical data obtained from MN, HB, PA and AS. There is a general trend of substitution of a low-content filler verb /budan/ "to be" for all types of verbs, as exemplified in writing samples of HB in several contexts. There are also multiple manifestations of substitution of the poly-morphemic infinitive form for the contextually appropriate inflected form of different types of verbs as observed in the writing samples of MN (see Nilipour, 2000). There is also evidence of reconstruction of verb inflectional morphology and truncations, as observed in the out-loud reading task by PA. The incidence of mixing languages and alternating recovery were observed in the case of languages that were structurally distant in their linguistic make up (see AS).

With respect to selective impairments of different language skills, as observed by neuropsychologists of language (Poeppel & Hickok, 2004), linguistic domains (i.e., production vs. comprehension) and subsystems (i.e., phonology, morphology, syntax) are not monolithic but have rich internal structure with numerous subcomponents and computational requirements. The present clinical linguistic data from different groups of aphasic patients with different and/or the same lesion sites provide support of evidence of selective impairment of different linguistic levels indicating to underspecification of functional anatomy of the classical

brain-language model (Poeppel and Hickok, 2004) in patients with same lesion site.

The incidence of double dissociation at the syntactic and lexical levels in the performance of two groups of aphasic patients with different lesion sites was observed in Rezaei's study (2008). As the clinical linguistic data from Persian speaking aphasics are so far limited on certain issues, our conclusions will have to be verified by further research on new Persian aphasic patients with different lesion sites and other languages using the same methodology and assessment tools.

Discussion

Based on the results, the present clinical linguistic data from a heterogeneous group of Persian aphasic patients suggest the compatibility of the observed distinction between general features as well as language-specific features reported by researchers in other languages (Menn and Obler, 1990). With respect to language-specific features, as observed by Paradis (2001, P.4) the larger the number of choices in a paradigm, the more vulnerable the item. The probability of this hypothesis was indicated in the multifaceted vulnerability of VP and the poly-morphemic Persian infinitive in different tasks and contexts. Also, the co-occurrence of different language impairments at various linguistic levels (morphology, lexical, syntax) which we observed in Persian aphasic patients with different focal lesions argues against the monolithic linguistic domains (production vs. comprehension) and language subsystems as observed in other languages and reported by other researchers (Menn and Obler, 1997; Poeppel and Hickok, 2004, P. 5).

The present clinical linguistic data are also in support of neuropsychological double dissociation proposed by Pulvermuller in patients with Broca's and Wernicke's aphasia after focal lesions (Pulvermuller 2004, pp.66-73). As the data in Rezaei's study indicated, the behavior of patients with Broca's and Wernicke's aphasia supports Pulvermuller's proposed neuropsychological double dissociation at syntactic and lexical levels (Figures 1 and 2). The comparison of mean syntactic comprehension scores and MLU of connected speech samples of patients with Broca's and Wernicke's aphasia is an index of neuropsychological double dissociation at the syntactic level. On the other hand, the comparison of the figures on TTR and function words (content vs. function words) of patients with Broca's and Wernicke's aphasia in which one feature is selectively damaged in one group of aphasic patients and not in the other group

suggest a neuropsychological double dissociation at the lexical level (Figures 2 and 3).

With respect to the shortcomings of the classical anatomical models regarding major aphasic syndromes (Broca's, Wernicke's and Conduction aphasia), as observed by Poeppel and Hickok (2004, P. 5) and other researchers, not only the classical areas of brain-language model are underspecified for each major aphasic syndrome, but there are other areas outside the classical regions implicated in language processing. As the major syndromes from Persian aphasic patients indicated (Tables 3 and 4), several incidence of Broca's and Wernicke's aphasia consequent to the same and/or different lesion sites are in support of Poeppel and Hickok's theory about the shortcomings and functional under-specification of the classical model (Poeppel and Hickok, 2004). Much remains to be learned about the neuropsychology of language. As our present data are limited, given the compatibility of our data in some ways with previous reports and new neuropsychological models of language, we hope the present clinical linguistic data will cast some new light on the neuropsychology of language.

Acknowledgments

This research has been funded in part by the research grant No. (801/4/85/483,(85-12-28) from the Deputy of Research, University of Welfare & Rehabilitation Sciences and the Clinical Linguistics grant by the Iranian National Science Foundation to the first author. The authors would like to acknowledge careful reading and valuable comments by Dr. Leonard Lewisohn from the University of Exeter and comments by Professor Michel Paradis from McGill University on the first draft of this paper. Any shortcomings remain the responsibility of the authors.

Declaration of Interest

The authors report no declarations of interest.

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