Date: Jan 12, 2010
To: "Maryam Ghaleh" maryam2133@yahoo.com
From: Henri Cohen henri.cohen@uqam.ca
Subject: Your Submission
Ms. Ref. No.: JNL-D-09-00052
Title: subcortical organization of languages in bilingual brain
Journal of Neurolinguistics

Dear Ms. Ghaleh,

Thank you for submitting your paper to JNL. I have received one very brief review of your paper, quite favorable. I have also carefully read your paper and agree that the results reported here are of great interest.

However, I would greatly appreciate that you address the following concerns in a revised version of your paper.

1) Please, adhere to the APA publication style for citing references in the text and listing the refs.

2) Please, mention all figures in the text. Figures 4 and 7 are not found in the text.

3) The figures representing the patients' Farsi and Turkish results on the BAT may not be necessary, as you are already providing a description of their performance in the ms.

4) Please, give the full reference for Kainz.

5) You need to include, at the end of the introduction, the aim and objectives of the study (and hypotheses, if warranted). A summary and conclusion are also needed.

6) The conclusion of your paper may be too strong, as you are reporting data on three patients only.

7) There has been recent work on the organization of language in the damaged bilingual brain, published by Michel Paradis on this topic. It would be appropriate to refer to this work.

8) Please, be more specific in the figure legends (CT scans), pointing precisely the localization of damage.

9) I would greatly appreciate if you would have the paper edited for English. Some sentences are awkwardly written. I suggest that you also follow the APA style guideline for writing a paper.

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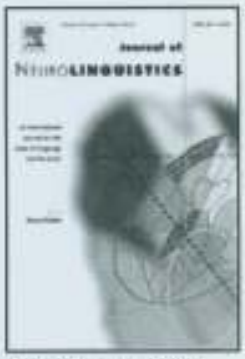

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Subcortical Organization of Languages in Bilingual Brain

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Abstract

One of the most important and least studied issues in neurolinguistics is the subcortical organization of languages in the bilingual brain. In this paper, the linguistic disorders and patterns of recovery in three aphasic patients with subcortical lesions in striatocapsular area have been studied. It was concluded that in bilinguals, languages might be lateralized in subcortical areas of the left hemisphere and that these subcortical structures might be more involved in speech production than comprehension. It was also suggested that the first language has more subcortical representation than the second language and the subcortical organization of languages in bilingual brain can change according to the age of acquisition of second language.

Keywords: subcortical bilingual aphasia, subcortical organization of language, striatocapsular area, language disorder, pattern of recovery

Subcortical organization of languages in bilingual brain

۱. Introduction

The organization of language in the brain has always been an interesting issue for linguists and neurologists. Although approximately ۸۰٪ of the world is bilingual, and ۷۵٪ is illiterate the current state of knowledge on the cerebral organization of language is based almost entirely on research conducted with literate monolinguals (Porch, & de Berkeley-Wykes , ۱۹۸۵).

According to current linguistic, psychological, and neurolinguistic approaches, the term ‘‘bilingual’’ refers to all those people who use two or more languages or dialects in their everyday lives (Fabbro, ۲۰۰۱a). Bilingualism does not imply a specific degree of proficiency in one or the other language (Meinzer, Obleser, Flaisch, Eulitz, & Rockstroh, , ۲۰۰۷).

From the neurolinguist’s perspective, the monolingual may be considered an unmarked case of brain organization for language and the bilingual as interesting modification that pushes us further to think about what we know about the ways the brain can be organized for language (Obler, & Gjerlow, ۲۰۰۰). One might expect that bilingual aphasics lose the two languages they spoke before insult to an extent proportional to their relative premorbid degree of mastery (parallel recovery). It is indeed often the case that they do, but not always. Sometimes polyglots become aphasic for only one or two of the languages they knew (selective aphasia). Sometimes they recover one language better than the other (differential recovery), or one after the other has been maximally recovered (successive recovery). Sometimes one of the languages is not recovered and remains forever unavailable (selective recovery) or the better recovered language deteriorates as the other improves (antagonistic recovery). Sometimes the first recovered language deteriorates several times in succession, so that each language is only alternatively available (alternate antagonistic recovery). In some cases the patient systematically mixes the two languages inextricably (mixed recovery) (Paradis, ۱۹۸۷). Recently the study of the linguistic behavior of bilingual aphasics has added to our knowledge about cortical organization of languages in bilingual brain.

Traditionally, aphasia has been regarded only as a language disorder caused by the damage to the language areas of the dominant cerebral cortex. However, since the late

١٩٧٠s, this traditional view has been challenged by the findings of an increasing number of cliniconeuroradiological correlation studies that have documented the occurrence of adult language disorders in association with apparently subcortical vascular lesions (Murdoch, ٢٠٠٤). As the result of these studies and the observation of cases with subcortical lesions suffering from language disorders, it was hypothesized that subcortical areas might be involved in language processing. Later studies determined some subcortical structures which had a role in language processing.

Subcortical structures which are often claimed to have linguistic roles include basal ganglia, the thalamus, the subcortical white matter pathways and cerebellum (Murdoch, ٢٠٠٤). Lesions in the area called striatocapsular or striatocapsular strokes have also caused language disorders in some cases. This area includes caudate nucleus, putamen, globus pallidus and anterior and posterior parts of internal capsule and subinsular area (Chung et al., ٢٠٠٠).

As noted earlier, the organization of language in bilingual brain is relatively different with that in a monolingual brain. However, studies on the subcortical organization of language in bilingual brain are very rare and only a few cases of bilingual subcortical aphasia have been reported (Aglioti, Beltramello, Girardi, & Fabbro, ١٩٩٦).

In ١٩٦٠s, Kainz suggested that often the best recovered language was a language the use of which was not automatic but rather depended on conscious efforts. He is of the opinion that aphasia mainly affects the most automatic language, namely the language which was used unconsciously (as cited in Fabbro, ٢٠٠١b, p. ٢١٣). According to Fabbro, when a second language is learned formally and mainly used at school, it apparently tends to be more widely represented in the cerebral cortex than the first language. However, if it is acquired informally, as usually happens with the first language, it is more likely to involve subcortical structures (Fabbro, ٢٠٠١b).

In ١٩٩٦, Aglioti and her colleagues reported the case of a bilingual aphasic patient (E.M.) with subcortical lesions mainly involving the left basal ganglia. This patient had more severe disorders in her most used mother tongue and her second language was the best recovered language. It was proposed that this type of recovery was related to the higher degree of automatization of the first language with respect to the second one (Aglioti et al., ١٩٩٦).

The present study seeks to explore subcortical bilingual aphasia and subcortical organization and lateralization of first and second languages in Farsi-speaking bilinguals. The subjects of this study comprised ۳ adult bilingual Farsi-speaking patients with symptoms of aphasia as a result of striatocapsular stroke.

۲. Case report

۲،۱. Case ۱ (S.S.A.[۱])

S.S.A was an ۸۲-year-old right-handed woman who was born in Sabzevar, north-east Iran. A local dialect of Turkish was her parents' mother tongue and the language they had used to talk to her at home. Since her parents knew Farsi as well, she learned this language when she was ۸. Therefore, S.S.A. is considered a bilingual with Turkish as her first and Farsi as her second language. She is an uneducated housewife who used to speak both languages with her relatives. She had an stroke in ۲۰۰۶ and was referred to us in ۲۰۰۸ for linguistic assessments. She could speak both languages fluently before the stroke.

۲،۱،۱. Clinical history

S.S.A. had an infarction in ۲۰۰۶ which caused her right hemiplegia. The CT scan of her brain showed a lesion in the left striatocapsular area (basal ganglia) (Fig.۱). She has been suffering from intensive motor disorder in the right part of her body and subcortical aphasia. The patient did not have any speech therapy or physiotherapy.

۲،۱،۲. Language assessment (October ۲۰۰۸)

S.S.A. was referred to us for linguistic assessments on ۷ October ۲۰۰۸ when she was unable to speak any of her languages. She had been diagnosed as having subcortical aphasia. She had also severe motor disorders and could not walk or move her right hand.

She was given a Farsi language modified version of Bilingual Aphasia Test (BAT) on the same day and a Turkish language modified version of BAT two weeks later. The Farsi test was administered by the present author and the Turkish one by patient's bilingual son. S.S.A was not able to produce speech in any of her languages and, as her family claimed, has not spoken a word after the stroke. The only sound she could

[۱] Patient's name in abbreviation

produce in answering the questions was a cluster of particular sounds which she used with the same order but different intonations in order to convey different senses. This sound cluster was /yebebebebe/. The patient could not pronounce this cluster in separate syllables. As an example, she was asked to produce /be/ or /ye/ but she could not. She was, however, able to express herself with body language which was also limited because of her motor deficits. For example, she could give positive or negative answers by head movements.

Patient's performance in pointing task was very weak, although it was better when Turkish was used. Generally, she could not get the meaning easily and everything had to be named several times for her so that she could point at it. She performed relatively well in simple and semi-complex commands. In Turkish her performance was better than in Farsi. She was not able to perform any of the complex commands in either language. The commands should be read one by one so that she could respond to one, two or three commands. Her best performance was in Turkish; she could perform three commands correctly but without order.

The patient's verbal auditory discrimination was relatively weak in both languages but better in Turkish. She was also very weak in performing syntactic comprehension task. She seemed to understand none of the sentences and pointed at a picture at random, sometimes even before the sentence was completely read. Since S.S.A. was unable to produce speech, she could not perform other tasks such as naming and repetition.

According to the test results, this patient had severe speech production disorders and impaired comprehension. Her pattern of recovery was differential ۳۱ months post-onset and Turkish was her best recovered language. As noted above, this language was her mother tongue and the dominant language of her environment after the stroke.

۲،۲. Case ۲ (M.M.)

M.M. was a ۷۳-year-old right-handed man who was born and lived in Ghuchan, north-east Iran. His parents' mother tongue was a local dialect of Turkish. They knew Farsi as well and used both languages to talk to M.M. . M.M. learned Farsi when he was ۲ or ۳. He used to speak to his friend in both languages in childhood but mostly spoke Turkish at home. Therefore he is considered an early Turkish-Farsi bilingual.

۲،۲،۱. Clinical history

The patient was an illiterate farmer. He had a stroke in ۲۰۰۷ which caused him severe motor disorders and aphasia. CT scan of his brain revealed a lesion in left striatocapsular area (Fig. ۲). He had no speech therapy or physiotherapy after the stroke.

۲،۲،۲. Language assessment (October ۲۰۰۸)

M.M. referred to us ۱۲ months post-onset, on ۲۲ October ۲۰۰۸. He had disorders in both languages and his aphasia was diagnosed as subcortical. A Farsi test was given to him on the same day and a Turkish one on the following day. The Farsi test was administered by the present authors and the Turkish one was administered by the assistance of patient's son-in-law who was a Turkish-Farsi bilingual. The patient was aware of his disorders and made efforts to improve his speech. Whenever he could not express himself, he cried.

M.M. had many problems in producing spontaneous speech. His speech was slow, nonfluent, effortful and interrupted, containing a relatively large number of repetitions. The production of Turkish language was easier for him and he spoke this language more fluently. The length of utterances he produced was very short and he mostly used simple and non-complex sentences without verb. His vocabulary was very limited, particularly in Farsi. He had some word-finding difficulties and as a result of paraphasias resulting in nonwords, many of the words he produced in both languages were incomprehensible. M.M.'s speech was grammatical and he had no difficulty in using grammatical words and correct word orders. Moreover, his speech was coherent and pragmatically correct.

M.M. had some difficulty in performing pointing task, his performance was better in Turkish though. He did well at simple and semi-complex commands tasks in Turkish. However, in Farsi, the commands were needed to be repeated several times and he performed them with difficulty and, sometimes, wrong. In the task of complex commands, M.M.'s performance was weak but better in Turkish. His performance in Turkish was better than in Farsi in verbal auditory discrimination and syntactic comprehension tasks as well. M.M. could not answer any of the questions in synonyms task and had difficulties in answering the antonyms one.

The patient's repetition of Turkish words and sentences was good and better than the repetition of Farsi words and sentences. He had several phonemic paraphasic problems in repetition of Farsi words. His lexical decision was spared in Turkish but totally impaired in Farsi.

M.M. could produce series completely. He just had some pauses in the production of Farsi series. In verbal fluency task he could not say even a word. His naming was spared in both languages.

In sentence construction task, the patient's performance was very weak. He could only repeat the words read for him, with the omission of some of them. M.M. could only answer one of the questions in semantic opposites task in each of his languages.

According to the BAT results, M.M.'s production was more impaired than his comprehension and his naming and repetition were spared. He had subcortical aphasia and differential pattern of recovery ۱۲ months post-onset. His best recovered language was Turkish which was his mother tongue and the dominant language of his environment after the stroke.

۲،۳. Case ۳ (F.Gh.)

F.Gh. is a ۵۲-year-old right-handed woman who was born and lived in Ghuchan, north-east Iran. Her parents' mother tongue was a local dialect of Turkish and they used to speak mostly Turkish at home. They knew Farsi as well and sometimes spoke Farsi with her. F.Gh. mostly spoke Turkish with her family and friends in childhood. As she said, she has learned Farsi in childhood but after Turkish. She could not remember the age of acquisition of Farsi. According to the history of bilingualism, she is considered an early bilingual.

F.Gh. had ۱۲ years of education and was a retired elementary-school teacher. The language of education at her school had been Farsi. It was also the language she used at work. Her husband was also a bilingual and she mostly spoke Turkish with him. Therefore, Farsi was mostly her language of education and work. F.Gh. had a stroke in ۲۰۰۸ and referred to us in ۲۰۰۹. She could speak both Farsi and Turkish fluently before stroke.

٢,٣,١. Clinical history

F.Gh. had a stroke on ١٦ January ٢٠٠٨ which caused her right hemiplegia. CT scan of her brain revealed a lesion in left striatocapsular area (Fig. ٣). After the stroke, patient had severe motor disorders in the right part of her body and subcortical aphasia. She has had some speech therapy in Farsi.

٢,٣,٢ Language assessment (June ٢٠٠٩)

F.Gh. referred to us for linguistic assessment ١٨ months post-onset, on ١١ June ٢٠٠٩. At that time she was unable to produce speech in Farsi and could only produce a limited number of incomprehensible words in Turkish. She had been diagnosed as having subcortical aphasia. She also had severe motor deficits and could not move her right hand or walk without any help.

The Farsi and Turkish tests were given to her at the same day. The Farsi test was administered by the present authors in the morning and the Turkish one was administered with the help of patient's bilingual husband and daughter in the evening. In spontaneous speech, F.Gh. was not able to produce any words and answered the questions with signs such as head movements and pointing. Her performance was relatively better in Turkish and she could produce some words which were incomprehensible as the result of paraphasias.

The patient's performance was very weak in Farsi pointing and simple and semi-complex commands tasks, while she was better in Turkish. In neither of the languages could she perform complex tasks. She could only perform one of the three commands at a time in Turkish. Her verbal auditory discrimination was also impaired. In addition, she had some disorders in syntactic comprehension.

F.Gh. could not answer any of the questions in synonyms and antonyms tasks in both languages. In repetition task, most of her answers were wrong since she produced words with phonemic paraphasia. There were only few words which she could repeat without phonemic substitution or omission. In sentence repetition task in Farsi, she could not even repeat a word. However, in Turkish she could repeat sentences with paraphasia which made them incomprehensible.

The patient could not produce series in Farsi but she was able to name three days of week with paraphasia and count to three in Turkish. Moreover she repeated every word she produced several times. She was not able to name anything in naming task in Farsi but she could name “pen” in Turkish and used this word to name other things in the task. She was unable to perform other tasks. She was aware of her disorders and cried whenever she could not express herself or perform the tasks.

According to the BAT results, this patient suffered from severe production disorders. Her comprehension and repetition were also impaired, although her production disorders were noticeably more severe. She had subcortical aphasia and her pattern of recovery was differential ۱۷ months post-onset with Turkish as the best recovered language.

۳. Discussion

The reported cases of subcortical bilingual aphasia are very rare and there is no other linguistics study of subcortical aphasia in Farsi and in Iran. On the other hand, since several variables are involved in these studies, the results are not definite. However, future studies on subcortical bilingual aphasic patients can add to the number of reported cases and help reach more definitive generalizations.

In this study, the linguistic behaviors of three bilingual right-handed adult patients (۲ women, ۱ man) with subcortical lesions have been assessed in order to determine the disorders in each of their languages and their patterns of recovery. All patients had subcortical aphasia resulting from left striatocapsular stroke. The time of language assessment was in their late phase and between ۱۲ to ۳۱ months post-onset.

First language of all these patients was Turkish and their second language was Farsi. They could speak both languages fluently before the stroke. All three patients had learned the spoken type of languages before the written type of them.

Based on the BAT results, all three subcortical aphasics had the same pattern of recovery, namely differential. In all of them, the best recovered language was their mother tongue which was also the dominant language of their environment post-onset. Therefore, it is suggested that perhaps patients with left striatocapsular lesions would

have differential pattern of recovery. E.M., the case studied by Aglioti had also differential pattern of recovery (Aglioti et al., ۱۹۹٦).

According to Kainz's theory (as cited in Fabbro, ۲۰۰۱b, p. ۲۱۳) about the cortical and sucortical representation of languages, as a result of subcortical lesions, patient's first language should be more severely impaired and less recovered. In contrast, second language is expected to be less impaired and better recovered. However, in the cases reported in this paper, first language was less impaired than the second one and recovered better.

Therefore, it is proposed that the subcortical organization of languages may be different in a bilingual brain. This difference might be due to the different ages of acquiring the first and the second languages. It is likely that the second language acquired at a higher age is represented more subcortically than the fist language. Although there exist a report of a case in which second language was the less impaired and the best recovered language (Aglioti et al., ۱۹۹٦). The age of the acquisition of second language was, though, not taken into account in that report.

It is suggested that, as the age of the acquisition of second language can affect the cortical organization of language, the differences observed in subcortical organization of languages can also be due to this factor. More studies on subcortical bilingual aphasics can test this hypothesis.

Since all three patients with subcortical aphasia had lesions in the left hemisphere, it might be concluded that perhaps in bilinguals, language is lateralized in subcortical areas as well as in cortex, and that this lateralization might be in the left hemisphere. Subcortical laterality of speech in left hemisphere has been first suggested for monolinguals by Hornickel and her colleagues (Hornickel, Skoe, & Kraus, ۲۰۰۸).

Moreover, in these patients who had subcortical lesions in left striatocapsular area, speech production was more impaired than comprehension. It can be concluded that these subcortical structures are more involved in the production of speech rather than its comprehension in bilinguals. This was also observed in several studies on subcortical monolingual aphasics (particularly with striatocapsular lesions) in different languages (De Boissezon et al., ۲۰۰۷; Radanovic, & Scaff, ۲۰۰۳).

٤. Summary and conclusion

The aim of this paper has been to study the linguistic disorders, patterns of recovery and organization of languages in three Farsi-speaking bilingual aphasic patients who had striatocapsular strokes. We suggest that subcortical structures might have a more important role in speech production than comprehension and that the first language might have more subcortical representation than the second language. It is also likely that languages are lateralized in subcortical areas of the left hemisphere. Moreover, subcortical organization of languages might correlate with the age of acquisition of second language.

Figures

Figure ١: CT scan of case ١ (S.S.A.). Lesion can be seen in the left basal ganglia.

Figure ٢: CT scan of case ٢ (M.M.). Lesion can be seen in the left striatocapsular area.

Figure ٣: CT scan of case ٣ (F.Gh.). Lesion can be seen in the left striatocapsular area.

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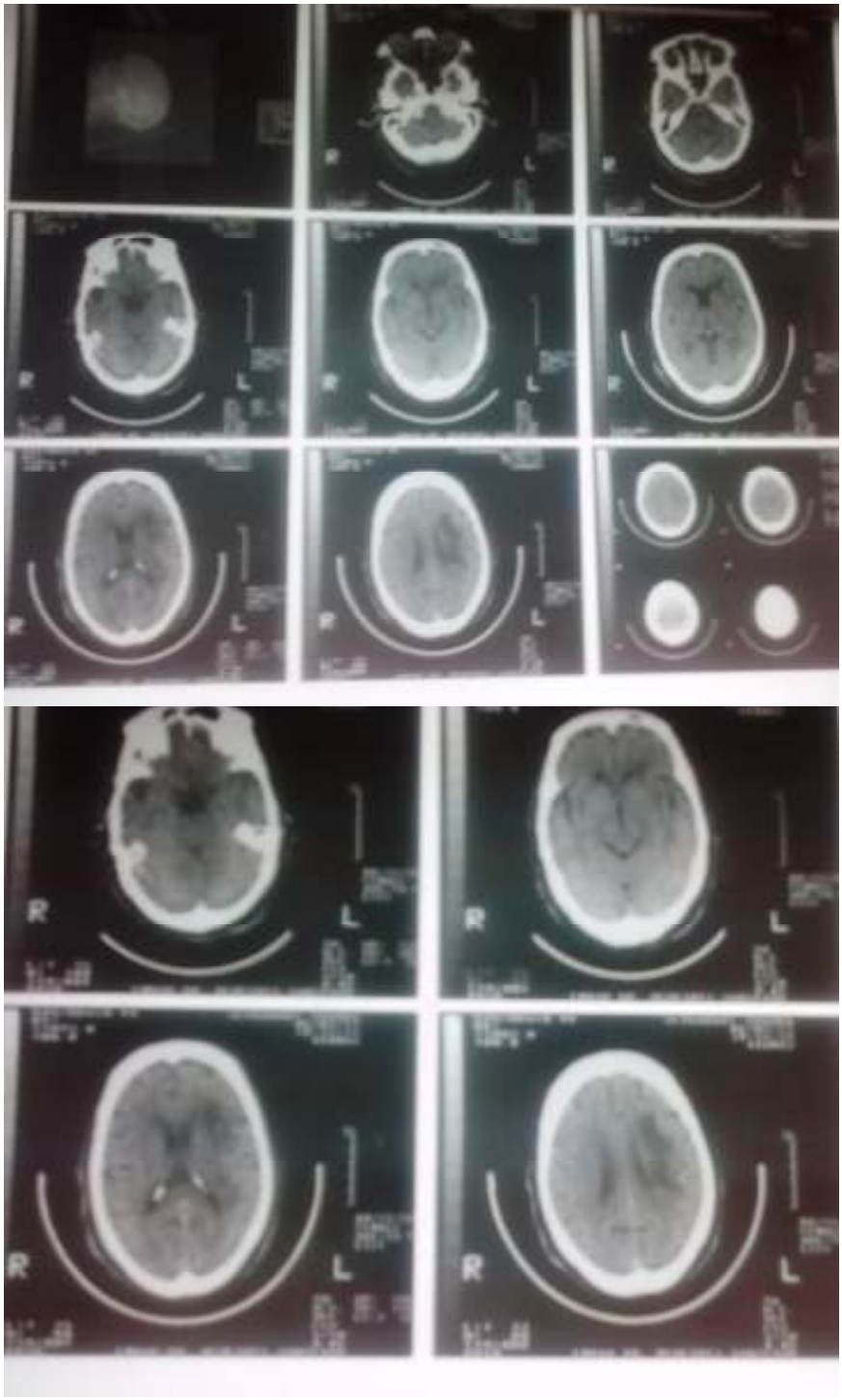

Figure ١: CT scan of case ١ (S.S.A.). Lesion can be seen in the left basal ganglia.

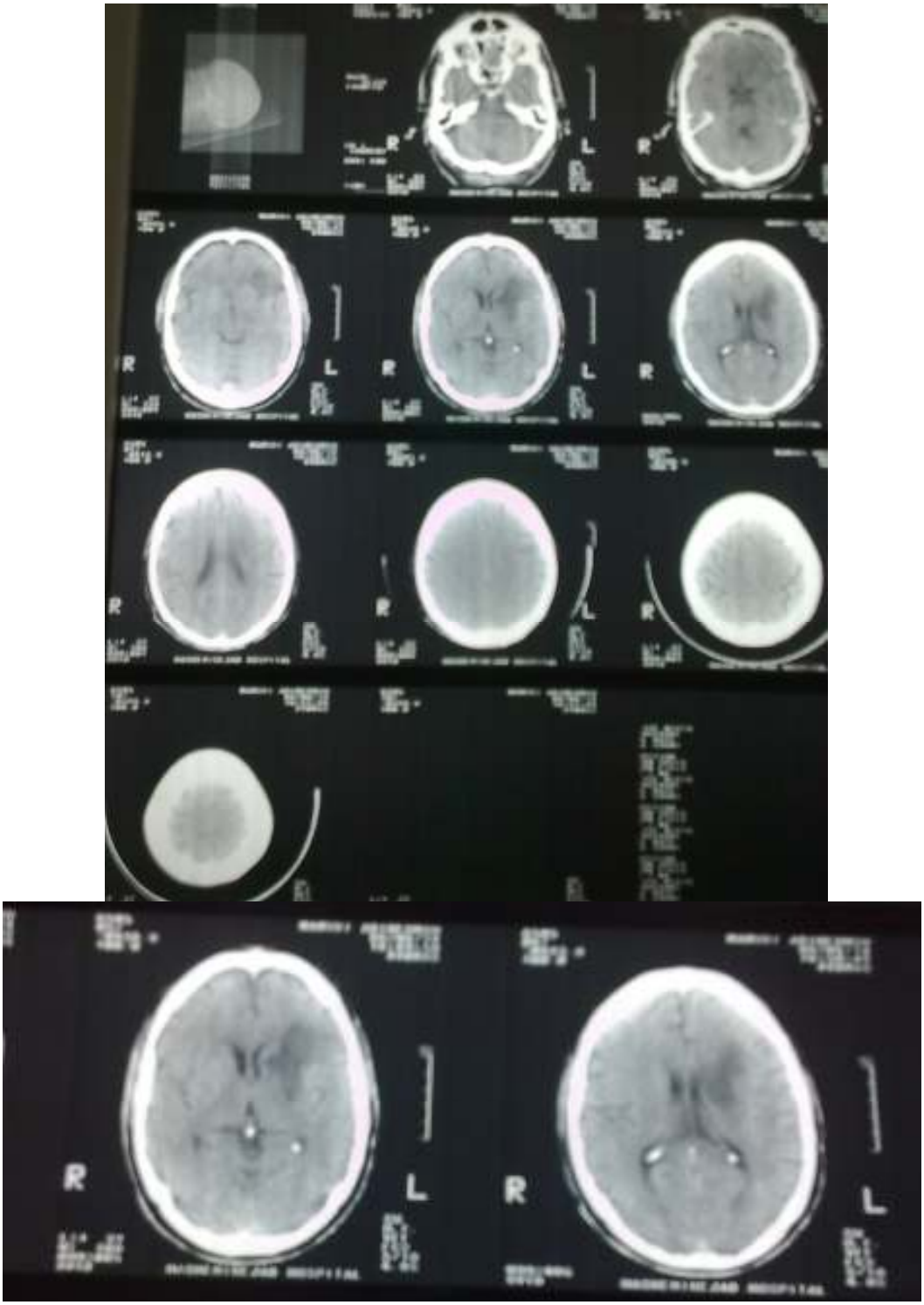

Figure ٢: CT scan of case ٢ (M.M.). Lesion can be seen in the left striatocapsular area.

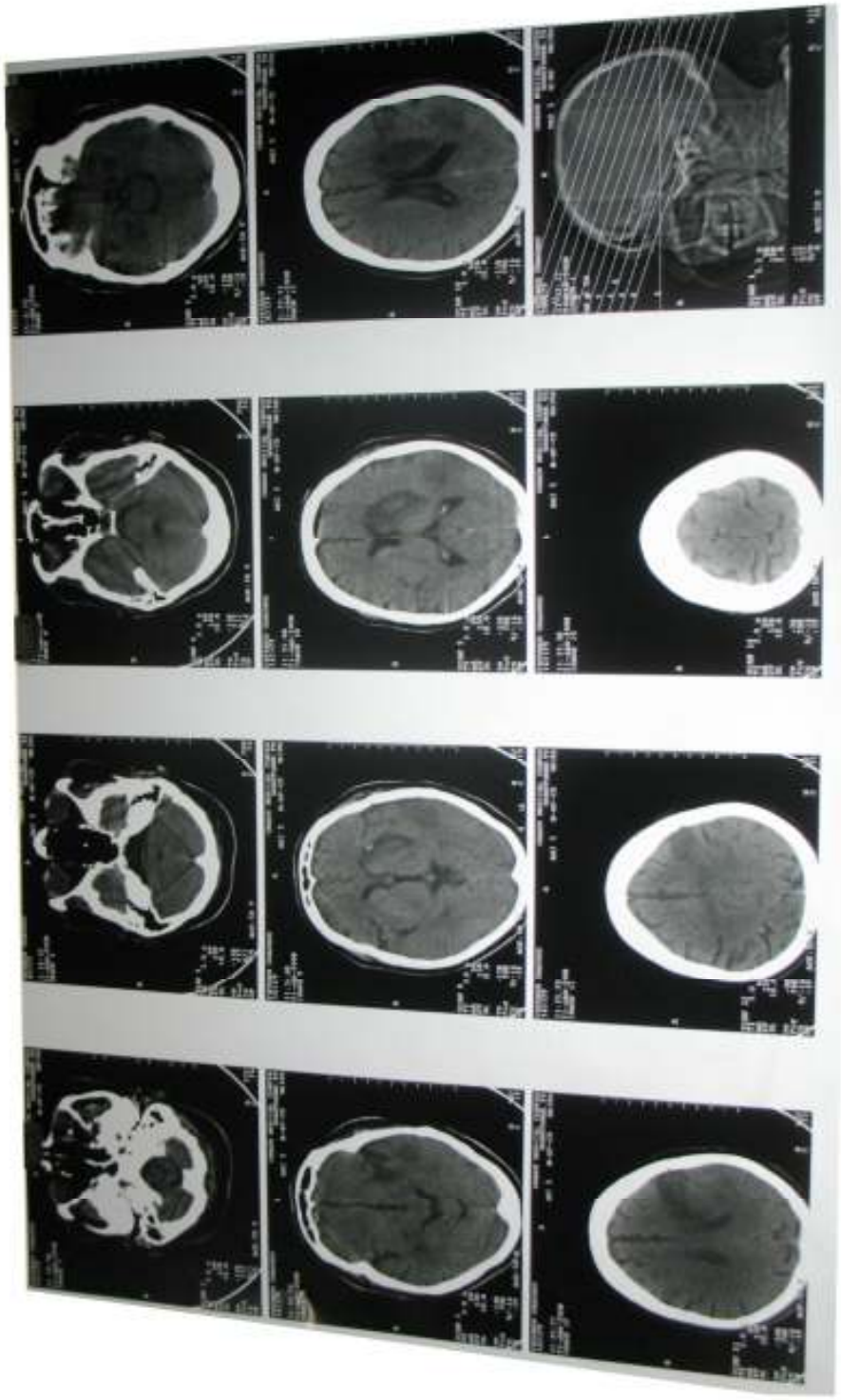

Figure ۳: CT scan of case ۳ (F.Gh.). Lesion can be seen in the left striatocapsular area.

سازمانبندی زیرقشری زبانها در مغز دوزبانه

محمودرضا آذرپژوه،[1] نادرجهانگیری،[2] مریم قلعه[3]

چکیده

سازمانبندی زیرقشری زبانها در مغز افراد دوزبانه یکی از مهمترین مسائل مطرح در زمینه عصب شناسی زبان است و تا کنون بررسی های بسیار محدودی بر روی آن صورت گرفته است. در این مقاله اختلالات زبانی و الگوهای بازگشت زبانها در سه بیمار زبان پریش مبتلا به آسیب های زیرقشری در ناحیه استریاتوکپسولار مغز مورد بررسی قرار گرفته اند. با توجه به داده های جمع آوری شده این نتیجه حاصل گردید که احتمالاً، در دوزبانه ها، زبانها در مناطق زیرقشری نیمکره چپ یکسویه می شوند و این مناطق در تولید زبان بیش از درک آن نقش دارند. همچنین به نظر می رسد که زبان اول نمود زیرقشری تری نسبت به زبان دوم داشته باشد و سازمانبندی زیرقشری زبانها در مغز افراد دوزبانه ممکن است با توجه به سن فراگیری زبان دوم تغییر کند

کلیدواژه ها: زبان پریشی زیرقشری دوزبانه، سازمانبندی زیرقشری زبانها، ناحیه استریاتوکپسولار، اختلال زبانی، الگوی بازگشت

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