

Neurolinguistic Analysis of a Case of Crossed Apraxia of Speech in Arabic

Mohamed Taiebne^{1,*}, Saadia Aidi², Maria Benabdeljlil², Mustapha El Alaoui Faris²

¹University Mohammed V. Faculty of Medicine and Pharmacy-Rabat, Morocco

²Department of Neurology A and Neuropsychology, Rabat Specialty Hospital, Souissi Quarter-Rabat, Morocco

Abstract Apraxia of speech (AOS) was studied in various occidental languages. However, no cases have been described in Arabic. In the current study, we present OJ who suffered from crossed apraxia of speech following right hemisphere damage. To our knowledge, until now there are merely three cases of crossed apraxia of speech (CAOS) that have been described in the literature. Therefore, our study will clarify the neurolinguistic symptoms that characterize CAOS and explore the phonetic encoding process. OJ 55-year old right-handed man with a right ischemic infarct on brain MRI. He was diagnosed as having a pure, severe CAOS with no aphasic impairment. He presented the classic triad of apraxia of speech: segmental distortions, temporal variability errors and finally Suprasegmental distortion which occurred inconsistently. The neurolinguistic pattern as shown in our patient errors resulted in a loss of phonetic encoding of both words and phrases. Therefore, our patient had (a) a quasi-preserved ability of phonological form of words that he intended to produce them, and (b) in the absence of paresis, ataxia, akinesia, or other problem related to motor control that would prevent the accurate execution of speech articulation.

Keywords Arabic speech production, Crossed apraxia of speech, Phonetic encoding, Neurolinguistic analysis

1. Introduction

Acquired apraxia of speech (AOS) is traditionally viewed as a disorder of speech programming that results from loss or failure to access segmental movement plans, and/or the subsequent assembly of segments to form cohesive syllables. AOS is a disorder that occurs following lesion of the language-dominant hemisphere. The disorder may occur following damage to frontal motor association areas [1] or to parietal regions [2]. It is generally viewed as a disorder at the level of the interface between completed language encoding and the phonetic implementation of the message. AOS is seen as a disorder of motor planning and cannot be explained in terms of failures of primary sensorimotor systems [3, 4]. It is not infrequent and may occur as an isolated disorder or, more usually, in association with aphasia. Despite its frequency, AOS remains poorly understood and a relatively under-researched impairment.

We report the fourth case in the literature of CAOS (See table 1), which may be interpreted as a disturbance at the level of the mental syllabary dedicated for phonetic encoding. Our case is interesting, because O.J. presents an impairment at the phonetic encoding process which appears to conform

to the theoretical predictions made about phonetic distortions in the context of crossed apraxia of speech [5, 6] and dal-route speech-encoding model [7]. The present study focused on this particular finding in the Arabic speaking.

To our knowledge, until now there are merely three cases of crossed apraxia of speech (CAOS) that have been described in the literature firstly by Balasubramaniana and Max [8] then Patidar et al. [9] following an ischemic infarct of the right hemisphere. Additionally, Assala et al [10] described progressive CAOS in a 64-year-old right-handed woman as the first manifestation of Corticobasal Degeneration with right perisylvian and insular atrophy on Brain MRI (See table 1).

Therefore, our study will clarify the neurolinguistic symptoms that characterize CAOS and explore the phonetic encoding process that could impair according to the cognitive model of the word production of Levelt [5] postulating the existence of mental syllabary dedicated for phonetic encoding.

2. Case Report

OJ 55 years old, right-handed (100%, Edinburgh Handedness Inventory), driver, married, with a high school background. He had an acute left hemiparesis with suspension of speech. The evolution was marked a few hours later by complete recovery of the motor deficit. The brain MRI shows a right peri-sylvian ischemic infarct (see Fig. 1).

* Corresponding author:

taiebinemohamed@yahoo.fr (Mohamed Taiebne)

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2.1. Neurolinguistic Assessment

The linguistic assessment was performed with the Moroccan version of MT86 which is the Protocole d'examen linguistique de l'aphasie [11]. The spontaneous speech is almost fluent, full of many phonetic and phonemic distortions. We noticed no agrammatism nor anomia. Repetition is better than the naming task, insofar as the phonetic and phonemic distortions are few. In the writing assessment, the different graphic transpositions in spontaneous writing, copying and dictation are successful. Reading comprehension is preserved. At the administration of the Moroccan Alexia-Agraphia Protocol [12] that consists of corpus of 113 words in Arabic and 20 non-words, the patient showed phonological alexia and agraphia. In writing words, he produced non-words and while he read non-words, he produced lexicalizations (See table 2).

Neuropsychological assessment has not objectified acalculia, homonymous hemianopia or visuo-constructive apraxia. However, he had a left ideo-motor apraxia. The upper and lower face apraxia test [13] allowed objectifying a moderate bucco-lingual apraxia with the presence of left buccal and lingual hypotonia. Perceptual Evaluation of the patient's voice showed a monotonous voice with a slight bitonality without tremor. The intensity is decreased with rapid vocal termination (release). There is a loss of modulation in intensity. The tone of voice is rather hazy. A closed rhinolalia is observed (hyponasality). We find a significant alteration of prosody with fluctuations in speech rate. At the phonetic level, there is an inaccuracy in production of consonants and vowels in the absence of palilalia. The patient is unintelligible in spontaneous speech due to the phonetic and acoustic impairment.

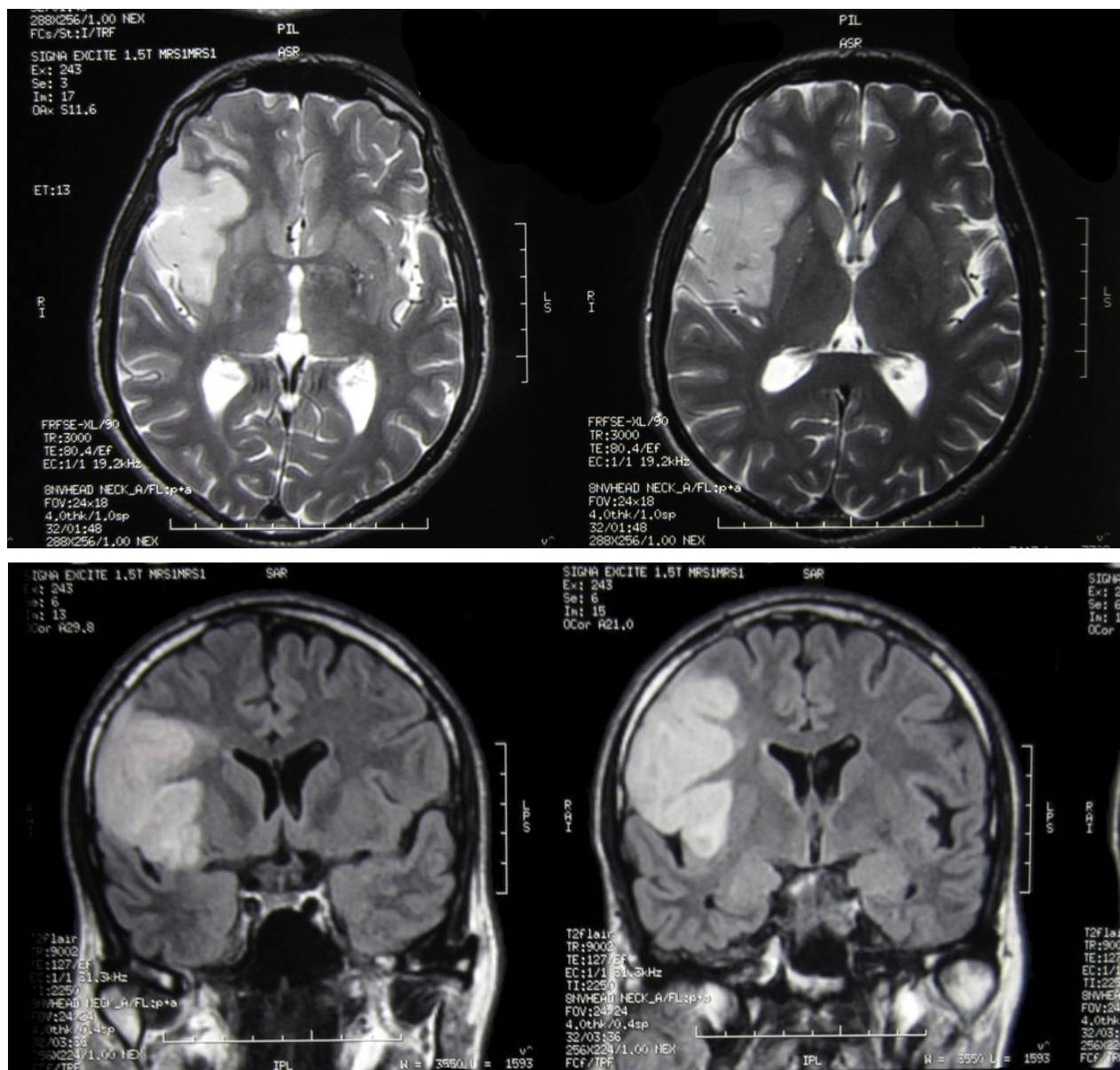


Figure 1. Brain MRI in axial, T1 (with gadolinium) and T2 sequences

Table 1. Effect of etiology and lesion topography in three reported cases of CAOS in the literature

Author	Case	Etiology and topography of the lesions
Balasubramaniana and Max [8]	A 69-year-old right-handed female (SE).	- A repeat CT scan revealed hemorrhagic cerebrovascular accident that lesioned the right frontal lobe under the anterior horn of the lateral ventricle, the head of caudate and putamen of the right hemisphere. - The left hemisphere was spared
Assala et al. [9]	A 64-year-old right-handed woman	- Progressive apraxia of speech (PAOS), followed by peripheral agraphia then a left corticobasal syndrome (CBS). - Neuroimaging (CT, MRI and FDG-PET) unequivocally showed progressive right hemispheric atrophy and hypometabolism.
Patidar et al. [10]	48-year-old right-handed man	- An ischemic infarct in right cerebral hemisphere - The involvement of right peri-insular and adjacent fronto-temporal subcortical white matter is most likely responsible for both AOS and Broca's aphasia. - The involvement of opposite cerebellar hemisphere as evident on PET scan is likely due to the diaschisis phenomenon

Table 2. Type, number and percentage of articulatory distortions in J.O speech

Types of phonetic and articulatory distortions	Number N=17	%	The sound in the target word (with transcription)	The sound error produced by the patient (with transcription)	Displacement of point of articulation
Anteriorization	3	17,6%	ش / (š)	س / (s)	Fricative+palatal----->fricative+alveolar
Anteriorization+ voicedness	2	11,7%	ح / (ħ)	خ / (x)	Fricative+pharyngeal----->fricative+uvular
Anteriorization+ voicelessness	1	5,8%	ز / (z)	ف / (f)	Fricative+alveolar----->fricative+labial
Anteriorization + constriction	-	-	-	-	-
Anteriorization + occlusion	1	5,8%	ف / (f)	ب / (b)	Fricative+alveolar----->plosive+bilabial
Posteriorization	5	29,4%	د / (d)	ن / (n)	Plosive+dental-->nasal+alveolar
Posteriorization + voicedness	2	11,7%	ص / (ṣ)	خ / (x)	Emphatic ----->fricative+velar
Posteriorization+ désonorisation	1	5,8%	ز / (z)	س / (s)	Fricative+alveolar----->fricative+alveolar
Posteriorization + constriction	1	5,8%	ق / (q)	خ / (x)	Plosive+uvular----->fricative+alveolar
Posteriorization + occlusion	-	-	-	-	-
Voicelessness	1	5,8%	د / (d)	ت / (t)	Plosive+dental---->Plosive+dental

3. Discussion

We report the fourth case in the literature of crossed apraxia of speech (CAOS) with selective damage to the phonetic encoding process, which the mean features as described by Ziegler [14]:

- Segmental distortions,
- Temporal variability errors
- Suprasegmental distortion which occurred inconsistently.

Furthermore, the typology for CAOS contains the additional following features:

- Prolongations of steady-state components of segments, and intersyllabic pauses [15].
- Reduced coarticulation [6],
- Initiation difficulties, as indicated by articulatory groping and struggle [16].

The neurolinguistic pattern as shown in our patient errors resulted in a loss of phonetic encoding of both words and phrases. Therefore, our patient had (a) a quasi-preserved

ability of phonological form of words that he intended to produce them, and (b) in the absence of paresis, ataxia, akinesia, or other problem related to motor control that would prevent the accurate execution of speech articulation. The issue is thus to transform the abstract representations of words into motor commands that guide the articulators parts of speech and program its position and the sequences of it as described by Darley et al [16].

The cardinal signs of apraxia of speech are a dysfluency associated with phonetic and phonemic distortions. The presence of such symptoms indicates that the patient is struggling for the realization of a stable target word at the phonetic level, and the fact that the symptoms are variable, is regarded as evidence in differential diagnosis in comparison with the most basic mechanisms within the motor speech framework such as dysarthria, paresis, ataxia, akinesia, dyskinesia / dystonia, etc.

Our patient has at least a severe crossed apraxia of speech because he is able to pronounce syllables or single words or even short phrases. He produces both phonemic and phonetic errors. The phonological errors refer to substitutions,

omissions or additions of phonemes. Another type of error is phonemic addition of consonant or consonant clusters, usually at the beginning of a word or syllable. The mechanism causing these errors has often been described as an articulatory or speech simplification.

A dual-route model of speech encoding proposes that high-frequency units are stored as movement gestalts, and are not assembled afresh each time that they are used. In the model proposed by Levelt [17-19], high-frequency syllables are stored in a mental syllabary. Levelt suggests that, because the form is retrieved directly from storage and without mediating assembly from sub-syllabic processes, it will differ in phonetic characteristics from forms that do require greater recourse to sub-syllabic computational processes. The dual-route speech-encoding hypothesis is a potentially fruitful one for speech pathology in general and in re-evaluating the underlying impairment in disorders such as AOS in particular. Whiteside and Varley [20] reviewed the characteristics of AOS and proposed that the underlying impairment in the disorder might be reconceptualised as damage to direct-route speech encoding, and a subsequent reliance on indirect-route encoding (see Figure 2).

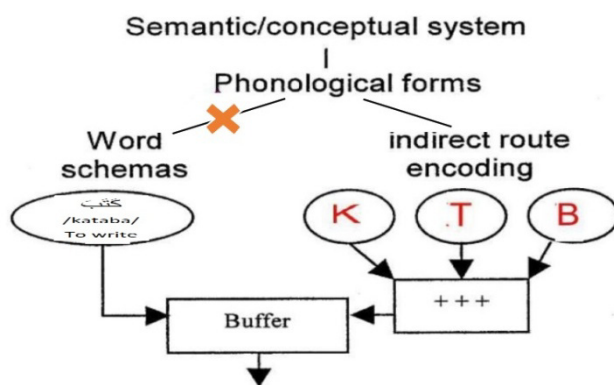


Figure 2. Dual-route speech-encoding model. The hypothesized impairment of the direct route in CAOS is indicated by the cross on the route between phonological form and word schemas

4. Conclusions

We report the fourth case in the literature of crossed apraxia of speech (CAOS) with selective damage to the phonetic encoding process. Our case study confirms the hypothesis that apraxia of speech can occur after injury to the right hemisphere in right-handed individuals. OJ speech was characterized by a moderate to severe crossed apraxia of speech. This study also indicates the need for further clinical data of patients and analysis of production of motor components of speech due to lesions of the right hemisphere. It is important to develop cognitive models of speech production in Arabic and to clarify the role of the right hemisphere in regulating phonetic and verbo-encoding process at segmental and suprasegmental level.

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