Writing Disorders of Languages

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Disclosure

None

Learning Objectives

Know the cognitive neuropsychology of normal writing
Test writing disorders
Know the cognitive classsification of central and peripheral agraphias
Know the anatomical localisations of different agraphias
Know the principles of rehabilitation of writing disorders
Know how neuro linguistic comparative studies can validate cogntive theory of writing

Outline

Overview of writing disorders
- History of writing disorders
- Common neurological classifications of writing disorders
- Cognitive neuropsychology of normal writing
- Testing of writing disorders

Cognitive classsification of central and peripheral agraphias
Anatomical localisations of agraphias
Rehabilitation of writing disorders
Crosslinguistic of writing disorders
Cognitive study of a pure agraphia in Arabic Language

OVERVIEW

History of writing disorders

Benedikt (1865) Applied the term of agraphia to the disorders of writing and described the relationship between agraphia and aphasia

Ogle (1867) Postulated that agraphia will appear separate from aphasia = two separate centers one for writing and another for oral language center

Lischteim (1885) Thought that writing disorders is the same as oral language disorders

Exner (1981) Described the agraphia due to frontal lesion (Exner's area)

Déjerine (1891) Postulated that orthographic and visual word images can be disturbed in agraphia

Wernicke (1886) Thought that writing utilize translation of sounds units into letters

Roeltgen (1993) , Beeson, RapcsaK, (2009)

Common neurological classifications of agraphias

Aphasic agraphias:

Association of the agraphia to a well identified aphasic syndrome

- Agraphia with Broca's aphasia
- Agraphia with Conduction aphasia
- Agraphia with Wernicke's aphasia

Roeltgen (1993)

Alexia with agraphia:

Presence of both reading and writing disorders

Déjerine(1892)

Pure agraphias:

Writing disorder in the absence of reading or oral language disorders

- Focal cerebral Lesion
  - Superior parietal lobe
  - Middle frontal gyrus (Exner's area)
- Writing disturbances in acute confusional state

Chedru, Geschwind.(1972)

Testing writing disorders

Testing the two major components of writing:

Linguistic and motor

Spontaneous writing: Name of the patient, address, history of the disease, Description of a picture

Writing dictation of varied single words:

- long vs short, common vs uncommon.
- word class (noun, verb, adjective, adverb, or function words)
- imageability (high vs low), abstractness (high vs low), regularity (regular vs irregular), or lexicality (real vs nonword).

Copying single letters, words, sentences

Writing comprehension

Testing other cognitive functions

- oral spelling, oral reading, oral naming, oral comprehension, limb praxis

Roeltgen.(1993)

Writing description of the cooking image
(BDAE, Goodglass and Kaplan, 1972)

Cognitive Neuropsychology of Writing

The cognitive process of writing was described mostly in the English language: Caramazza, Micelli.(1990); Ellis.(1993)

The theory of two routes to write a word postulates the existence of a phonological route and a lexical route

Ellis.(1993); Roeltgen, Heilman.(1984)

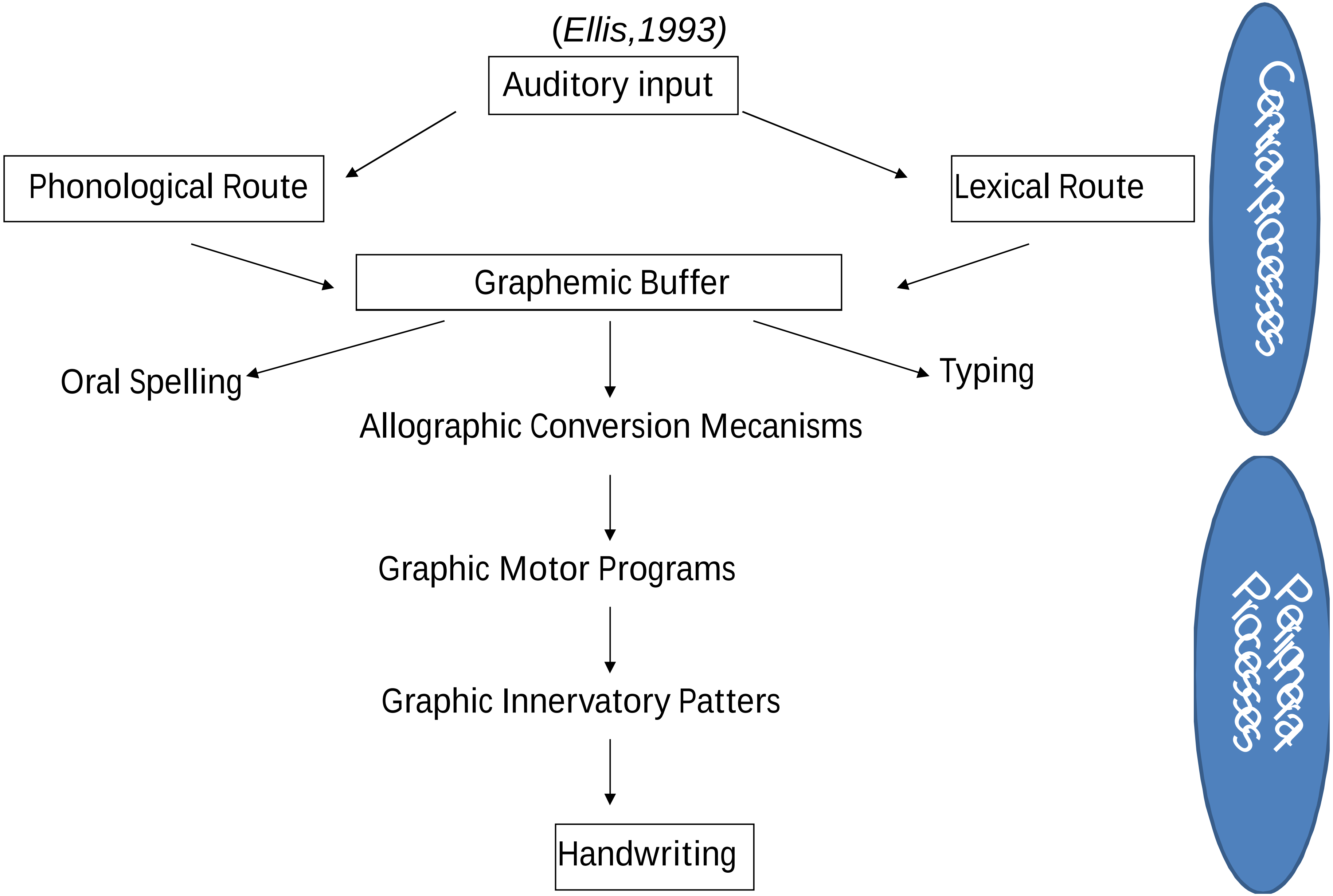
This cognitive model of writing is composed of two processes:

- Central processes:
  - Linguistic part: lexical and phonological processes
  - Graphemic Buffer (working memory of letters)
- Peripheral (motor): cognitive processes for the physical writing of letters

Beeson, RapcsaK, (2009)

Schematic diagram of the spelling process

(*Ellis,1993*)



DIFFERENT COGNITIVE TYPES OF AGRAPHIAS

1. CENTRAL AGRAPHIAS
2. PERIPHERAL AGRAPHIAS

1. Central Agraphias

Lexical Agraphia

Phonological/Deep Agraphia

Graphemic Buffer Syndrome

(Beeson and Rapcsak, 2009)

Lexical Agraphia

Also called surface agraphia

Regular words and non-words are spelled better than irregular words

Phonological misspelling

Homophone confusions

Phonological/Deep Agraphia

Words are written better than non-words

Spelling accuracy is influenced by lexical semantic strategy (concreteness, word class, and frequency)

Presence of plausible phonological and/or morphological errors

In deep agraphia: additional production of semantic errors (boy-girl)

Graphemic Buffer Syndrome

Spelling accuracy is notably affected by word length: each additional grapheme increases the demand on limited storage capacity

Spelling is not significantly influenced by lexical status, lexical-semantic features or orthographic regularity

Production of letter substitution, omissions, additions or transpositions

2. Peripheral Agraphias

Allographic agraphia

Apraxic agraphia

Nonapraxic disorders of motor function

(Beeson and Rapcsak, 2009)

Allographic agraphia

Inability to generate or select correct letter shapes in handwriting

Normal oral spelling

Substitution of physically similar letter forms

Case mixing errors

May be specific to case (upper vs lower) or style (print vs cursive)

Apraxic agraphia

Poor letter formation not attributed to allographic disorders, sensori-motor, cerebellar or extrapyramidal dysfunctions

Production of gross errors of letter morphology, spatial distorsions, stroke insertions and deletions

Writing may be completely illegible

Nonapraxic Disorders of Motor Function

Defective regulation of movement forces, speed, and amplitude in handwriting production

Micrographia (Parkinson's disease)

Disjointed and irregular writing movements (cerebellar disorders)

Cognitive Classification of Writing Disorders

Disorder	Symptoms
Lexical Agraphia	Regular words are written better than irregular words
Phonological Agraphia	Words are written better than non-words
Graphemic Buffer Syndrome	Short words are written better than long words (length effect) no grammatical effect
Allographic Syndrome	Disturbance in transcoding the different forms in letters (upper vs lower) or style (print vs cursive)
Apraxic Agraphia	Letters are malformed

Anatomical Localisations of Agraphias

Anatomical Localisations

Roeltgen (1993); Rapcsak, Beeson (2002); Hillis (2008); Planton et al.(2013);

Lexical Agraphia (Anatomical Localisations)

- Focal damage to left temporo-parieto-occipital region
- Neurodegenerative damage of the same regions in:
  - Alzheimer’s disease
  - Semantic dementia

Phonological/Deep Agraphia

(Anatomical Localisations)

Damage to the Perisylvian language areas

Including Broca's area

Wernicke's area and the

Supramarginalus gyrus

Graphemic Buffer Syndrome

(Anatomical Localisations)

Damage in the left fronto-temporal networks involved in the working memory functions

Allographic Agraphia

(Anatomical Localisations)

Damage to the left temporo-parieto-occipital region

Apraxic agraphia

(Anatomical Localisations)

Damage to the left cortical network dedicated to the motor programming of handwriting movements : mostly the posterior-superior parietal cortex

Nonapraxic disorders of motor function (Anatomical Localisations)

Basal ganglia, cerebellum, dorsolateral premotor cortex and the supplementary motor area (SMA) are critically involved in the selection and implementation of kinematic parameters for writing movements.

REHABILITATION

Rehabilitation (1)

The study of some single cases of agraphia provide the clearest evidence that writing disorders may improve after cognitive rehabilitaion

Rehabilitation (2)

Treatments for central agraphias may be directed toward the lexical-semantic or the sub-lexical spelling routes, or the interaction between these complementary spelling procedures

Rehabilitation (3)

Treatment of lexical agraphia

Focus on the link between specific orthographic words and their meaning

Treatment of Phonological agraphia

Focus on the link between phonology and orthography (sound-letter correspondance)

Rehabilitation (4)

Treatment for peripheral agraphias

Are designed to improve the selection and implementation of graphic motor programs for handwriting

CROSS-LINGUISTIC STUDIES OF WRITING DISORDERS

Cross-linguistic studies (1)

The cognitive model of two routes of writing was developed essentially from the study of the English language and it seems to be applied to other alphabetic languages such as French and Italien

Shallice (1981)

Cross-linguistic studies (2)

However, there is little knowledge regarding the application of this model to the logographic scripts such as Chinese or Japanese or to consonantic writing (Arabic, Hebrew)

Han et al (2009); Nakamura et al (2000)

El Alaoui Faris, Taiebine (2013)

Cross-linguistic studies (3)

We applied the cognitive model (two routes) to study a case of pure agraphia in Arabic, a consonantal transparent writing

WRiTING ARABIC

Writing Arabic

Arabic is a cursive script, written from right to left, mostly consonant, in which vowels (diacritics) are not including in the word

Composed of 29 consonants and 8 vowels (long and short)

The Arabic letters differ in form depending on whether they appear at the beginning, middle or end of a word

Consonants are written as cursive characters

Vowels are written as diacritics above or below the consonants

Arabic Diactitics (vowels)

Without diacritics (vowels)

With diacritics (vowels)

COGNITIVE STUDY OF A PURE AGRAPHIA IN ARABIC

Pure Agraphia in Arabic

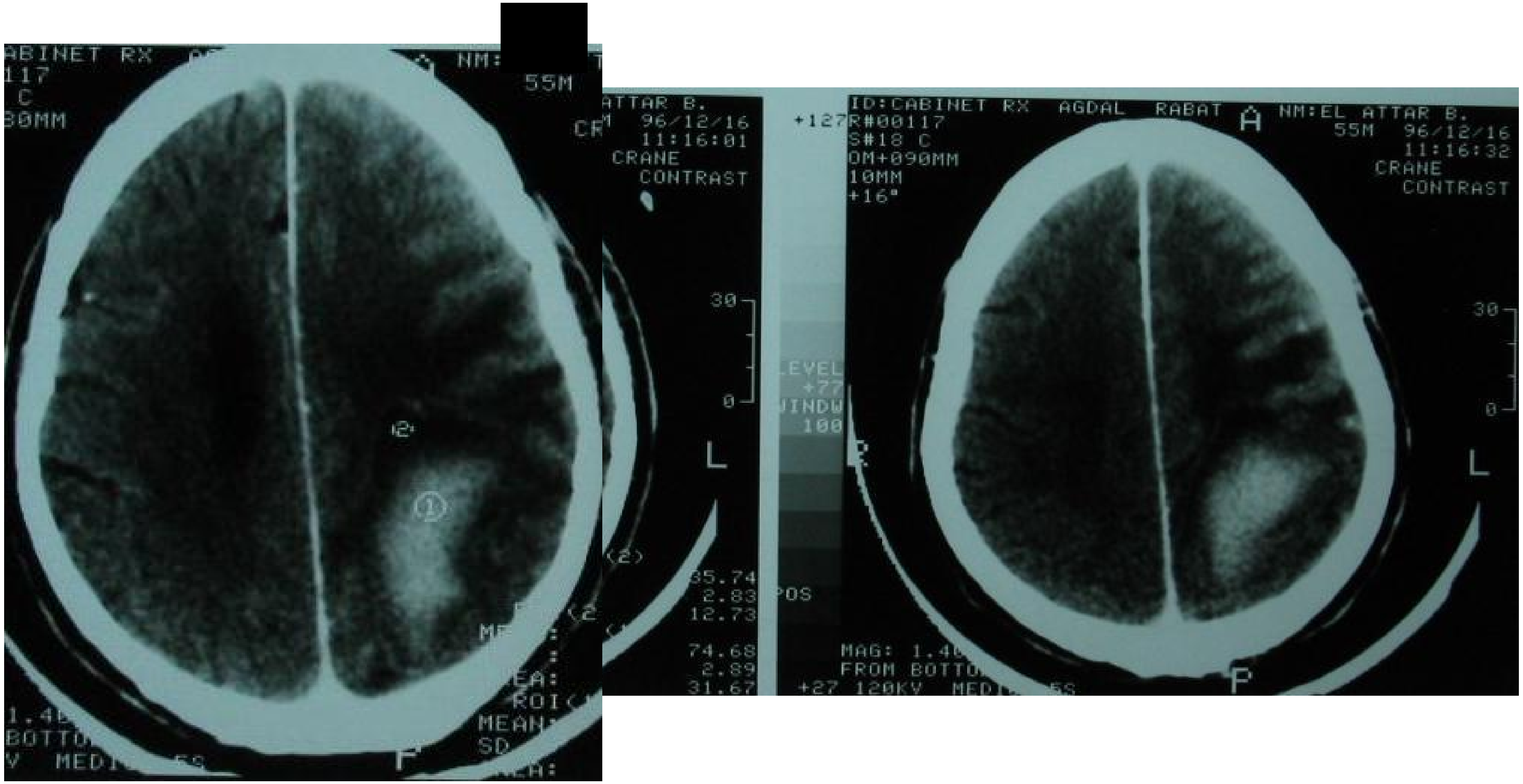
E.B., a 56 year old man, right handed, university professor of Arabic, with hypertension

Suddenly demonstrated a fluent aphasia with agraphia without alexia

He has quickly completely recovered spoken language

However, a severe agraphia has persisted

Cerebral CT Scan



Left Parietal Haematoma

Study of Oral Language

Oral language was normal without paraphasias (Moroccan version of MT 86*)

Oral comprehension, object naming, and repetition of words and non-words were normal

* Montreal-Toulouse Protocol of Linguistic Examination of Aphasia

Neuropsychological assessment

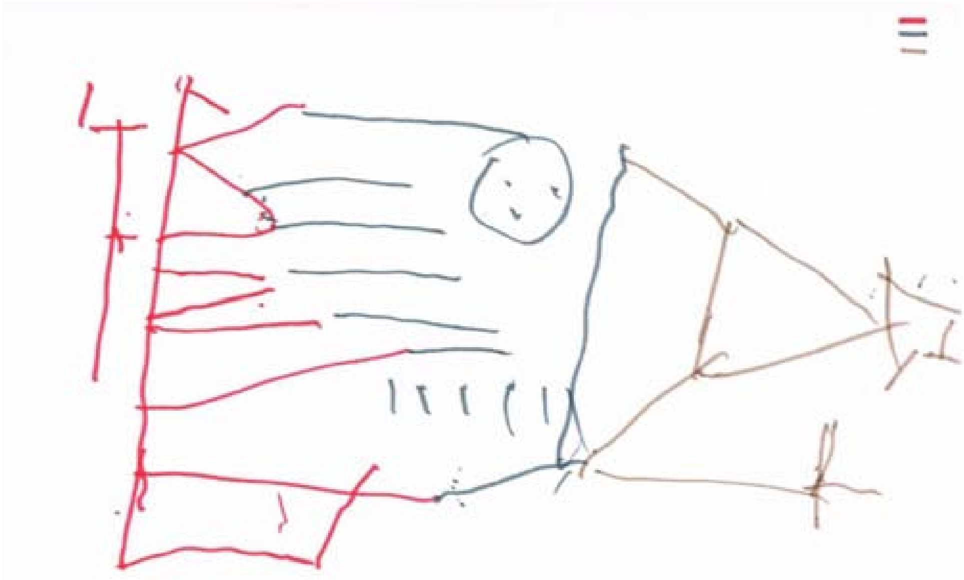
The following cognitive functions were disrupted:

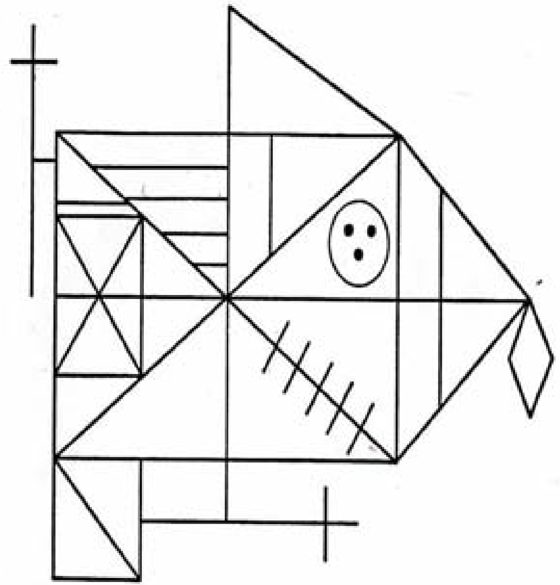
Verbal and Visual Memory

Mental and Written Arithmetic

Constructional praxis

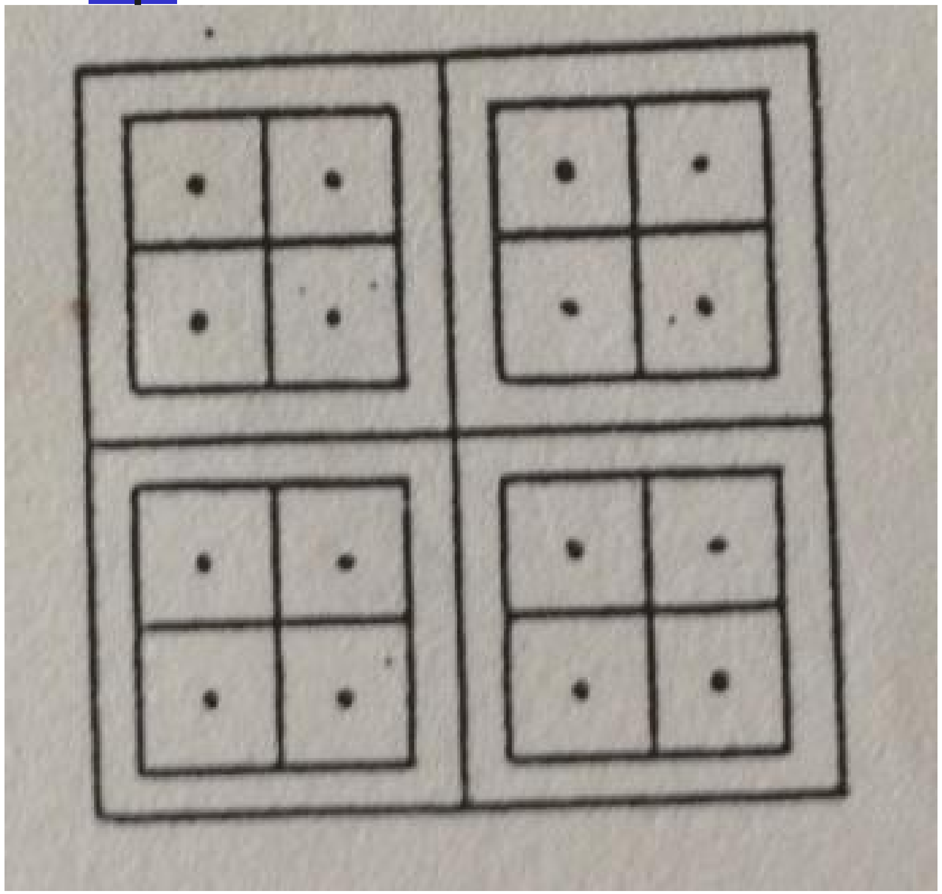
Copy of the Rey figure
(Constructional Apraxia)

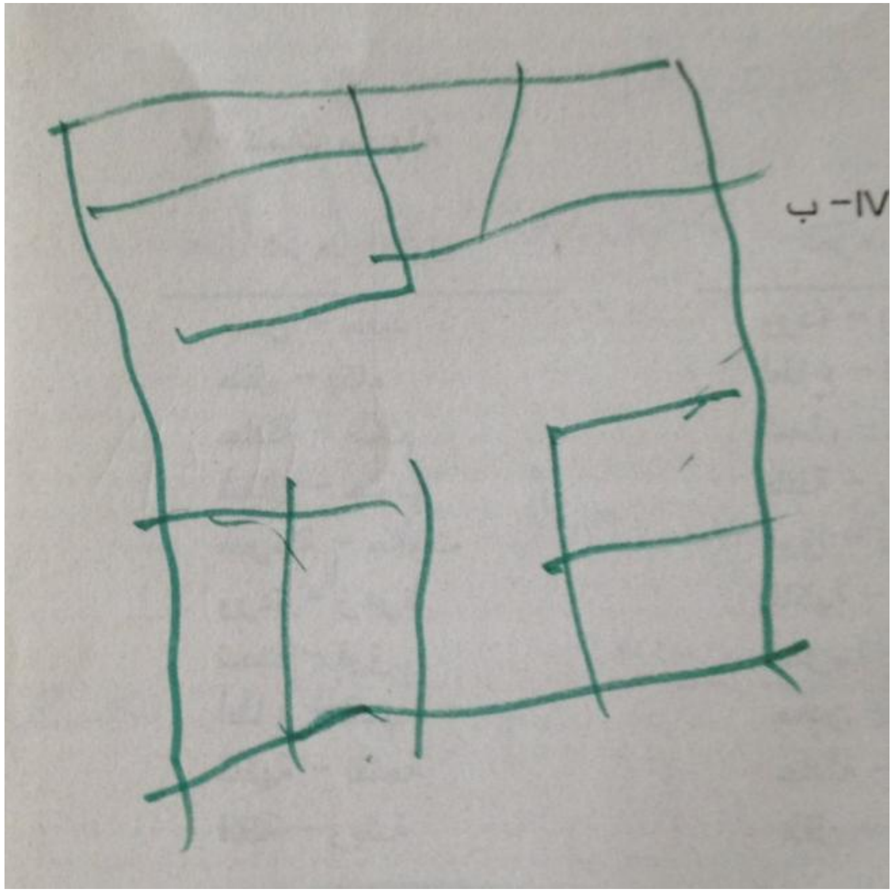




Wechsler Memory Test

(Visual Memory Disturbance)





Study of Reading, Oral Spelling and Writing

Study of Reading

The following assessments of reading were normal:

- Knowledge of the general shape of the letter
- Name and designation of the 28 Arabic consonants
- Reading of 113 words and 20 non-words
- Reading two texts with and without diacritics
- Reading of numbers

Study of Oral Spelling

- Even if the oral spelling is not used in teaching Arabic
- We asked the patient to spell 60 words including 10 polyconsonant words, and 20 non-words.
- Patient completed this test without difficulty
- He also recognized easily 10 words spelled by the examiner

Study of Writing

Spontanous writing (image description)

Writing of letters (dictation, copying, transcoding)

Writing of words (dictation, copying, delayed copying transcoding)

Dictation of 133 words

Taking into account the different linguistic parts of words, word length and the effect of concreteness

Dictation of 20 non-words

Spontaneous writing

E.B. writes with the right hand in normal position

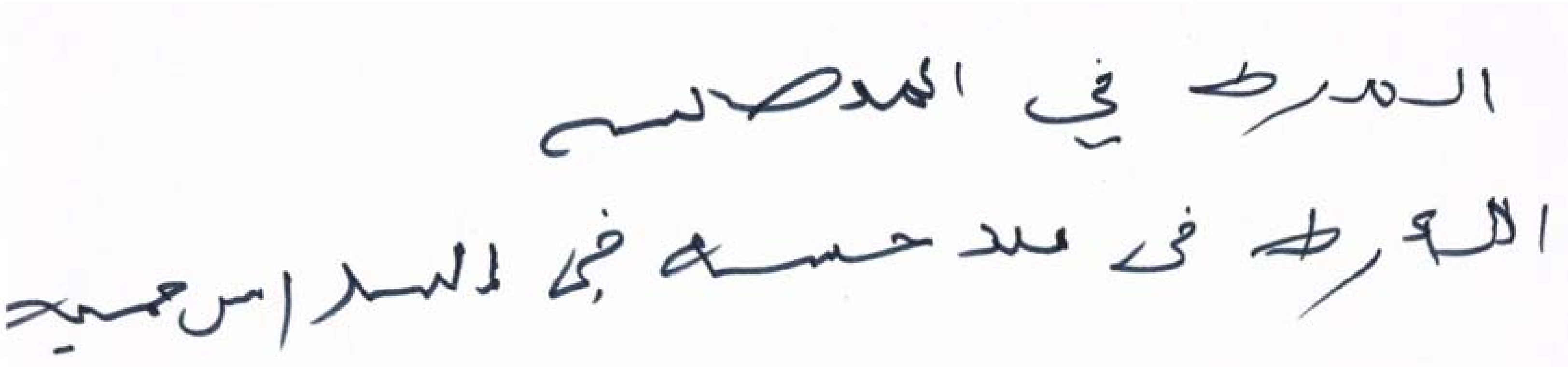
The writing was fluent with production of letter substitutions and graphemic approaches

Some letters are malformed

There are few diacritics

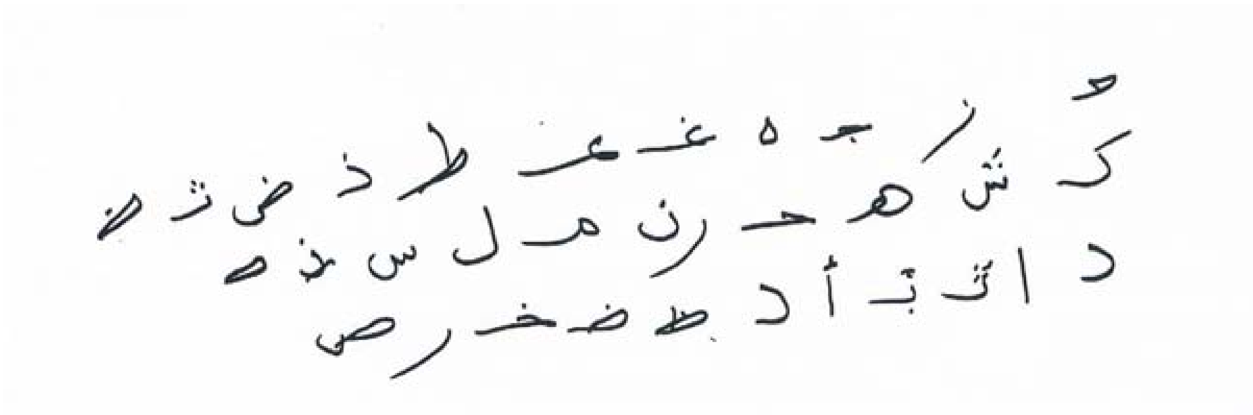
Description of the cooking image

(BDAE, Goodglass and Kaplan, 1972)

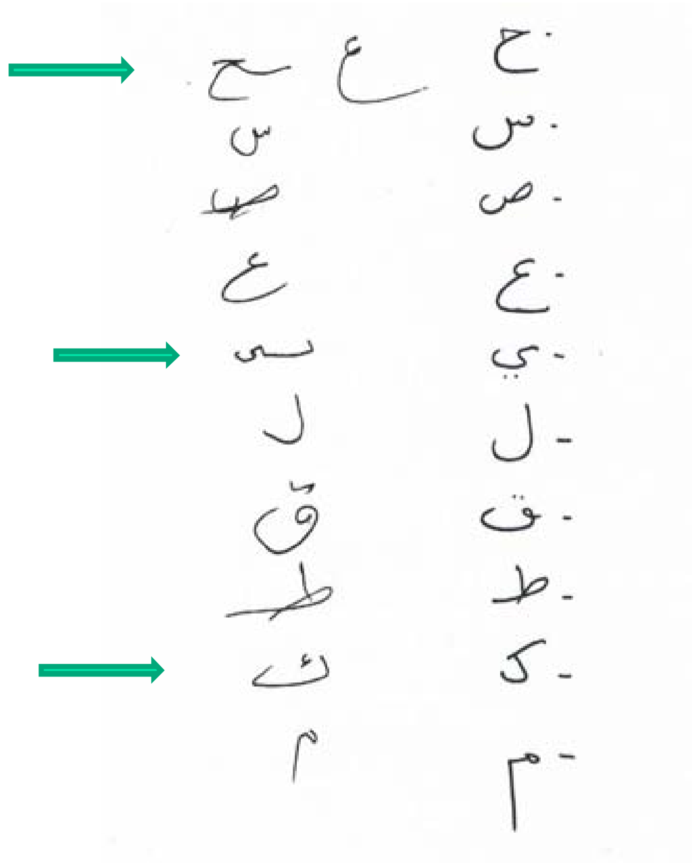


Jargonagraphia
No diacritics

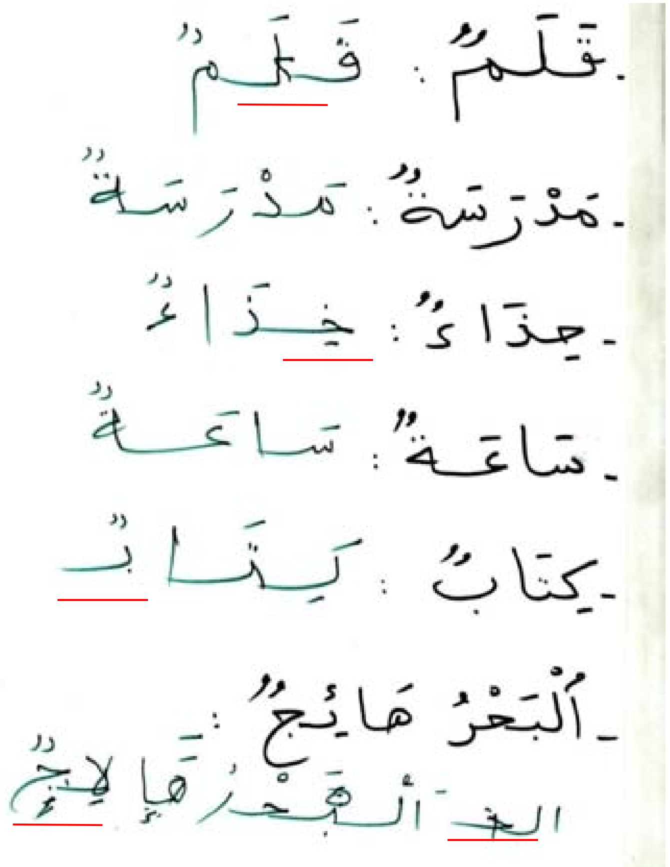
No Problems in the Dictation of letters



Few Errors in Direct Copying of Letters



No problems in direct copying of words



Transcoding Tests

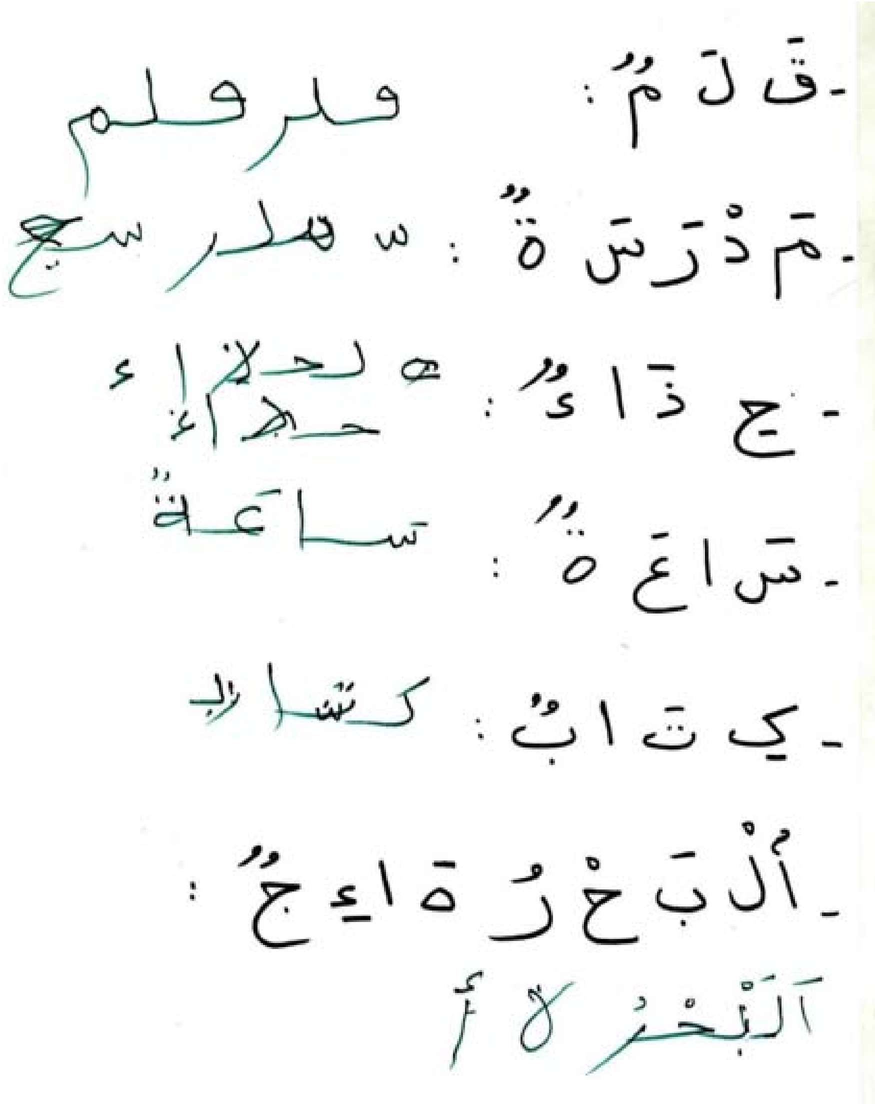
Given that the Arabic letters differ in form depending on whether they appear at the beginning, middle or end of a word

We asked the patient to transcode letters in end forms to those in middle forms

Transcoding isolated letters

Patient is unable to transcode the letters which means there is an allographic disturbance

Transcoding of Words



Patient is unable to transcode « separate letter-words » in using cursive writing Again, this indicates the allographic disturbance

Dictation of words and non-words

Dictation of 133 words

taking into account the different linguistic parts of words, word length and the effect of concreteness

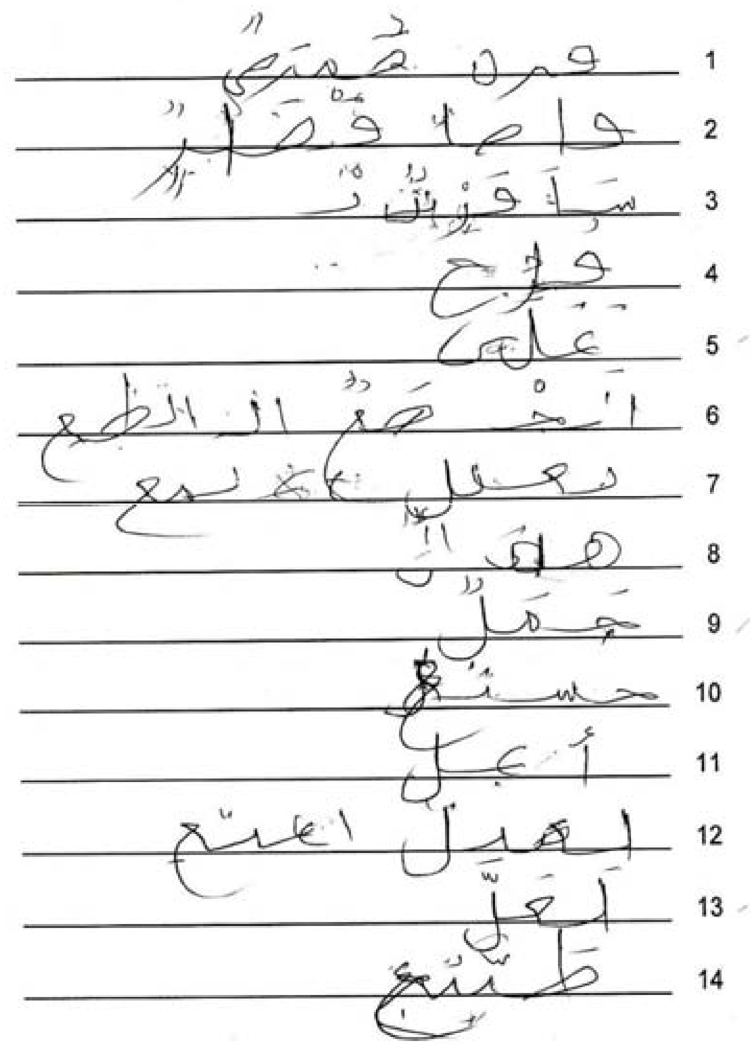
Dictation of 20 non-words

Dictation of words

Graphemic Approach

Letters substitution

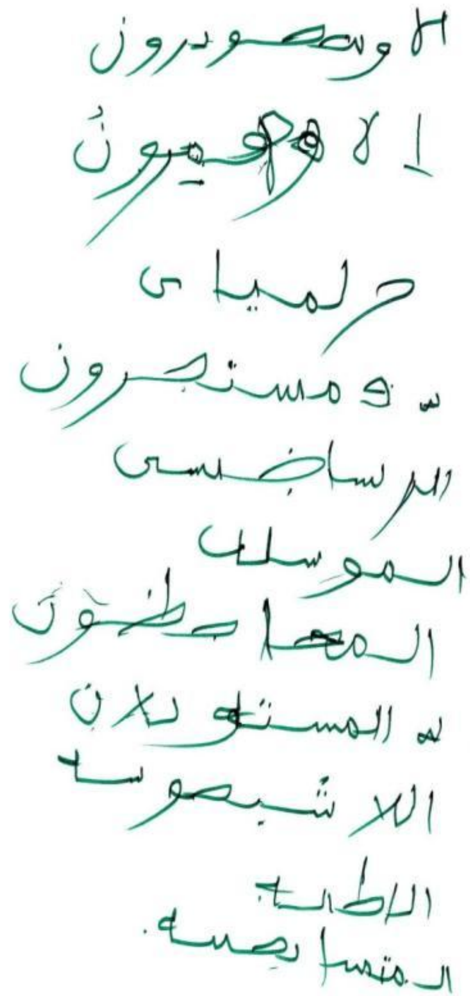
Malformed letters



Dictation of polyconsonant words

Total jargonagraphia

Effect of the length of the word = Graphemic Buffer Disturbance

Patient	*Target*
	ياضيون حلويات الْمُؤَسَّسَاتُ الْمُحَافِظُونَ الْمُسْتَقِلُّونَ الْمُسَابَقَاتُ الْمُسْتَشْرِقُونَ

Dictation of 133 words: Analysis of letter's errors

Errors are mainly letters' substitution or omission

Letters' substitution affect the end and the middle of the word

In some words the letters are tangled or poorly-identified

Dictation of 133 words: Analysis of letter's errors

	Beginning	Middle	End	%
Substitutions	11	23	26	60 (34 %)
Omissions	6	14	37	57 (32 %)
Additions	3	11	2	16 (9 %)
Inversions	0	2	2	4 (2 %)
Persévérations	0	0	2	2 (1 %)
Superpositions of 2 letters	7	8	11	26 (11 %)
Unidentified letters	0	8	5	13 (7 %)
Total	27 (11 %)	66 (36 %)	85 (53 %)	178 (100 %)

Which Cognitive processes of writing are disrupted in our patient?

1- Graphemic Buffer Syndrome

- Spelling is not significantly influenced by lexical status (words vs. nonwords), lexical-semantic features (concretness, word class, frequency)
- Spelling accuracy is notably affected by word length

Caramazza , Miceli. (1990)

2-Allographic Disorders

Errors in transcoding letters and words

De Bastiani and Barry (1989)

3-Apraxic Agraphia

Impairment of graphic motor programs (some letters are malformed)

Roetgen and Heilman (1983)

Schematic diagram of the spelling process: Levels disturbed in our case shown in red

Auditory input

Phonological Route

Lexical Route

Graphemic Buffer

Oral Spelling

Typing

Allographic Conversion Mecanisms

Graphic Motor Programs

Graphic Innervatory Patters

HandWriting

Central Processes

Peripheral Processes

What conclusions can be drawn from this case?

Modern cognitive models can be applied to Arabic writing

We found three major cognitive mecanisms in our case : Graphemic, Allographic and Praxic

In other works, we have described other classic cognitive syndromes in both writing and reading Arabic: Phonological Agraphia and Phonological Alexia

The fact of knowing the mechanism of agraphia can provide a rational approach to the rehabilitation of writing disorders

Rehabilitation of our case(1)

There were no improvement of the agraphia after 6 months of classical speech therapy

Taking into account the fact that oral spelling is normal, and that the main disturbance is at the graphemic buffer level (a working memory of letters), we proposed the following method for the rehabilitation of this case

Rehabilitation of our case (2)

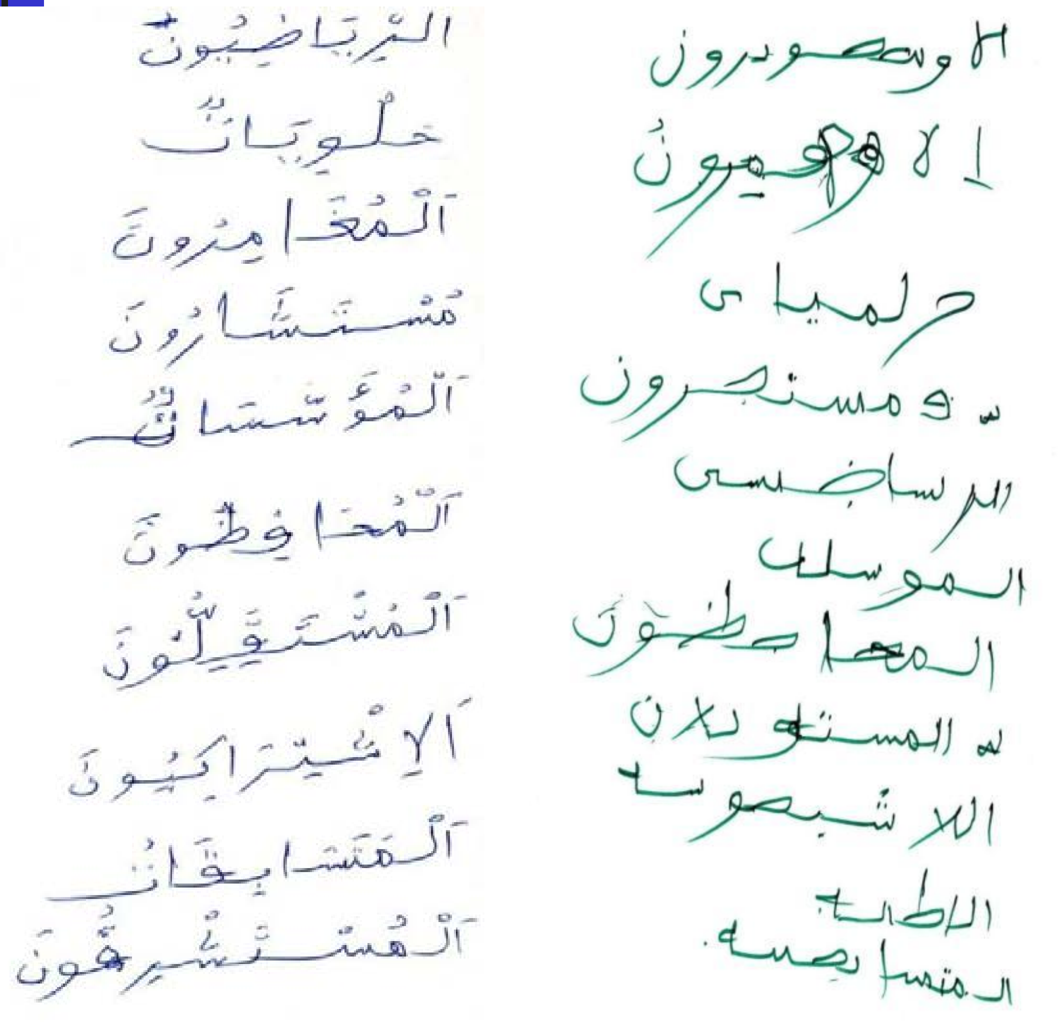
Patient should mentally visualize each letter of the word and then the whole word before writing it

We started with short words (three consonants), and then gradually increase the number of consonants

After 4 months of intensive rehabilitation, the patient was able to write correctly words and sentences

Dictation of polyconsonant wc before and after rehabilitation

After Rehabilitation	Before Rehabilitation	Target



الرِّيَاضِيُّونَ

حَلَوِيَّاتٌ

الْمُؤَسَّسَاتُ

الْمُحَافِظُونَ

الْمُسْتَقِلُّونَ

الْمُسَابَقَاتُ

الْمُسْتَشْرِقُونَ

Thank you for your attention