

# THE VALUE OF THE CANTAB BATTERY IN EVALUATING COGNITIVE DISORDERS IN EPILEPTIC PATIENTS

## ABSTRACT

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Epileptic process generate, depends on the cerebral region affected, a variety of neurological impairments, besides a wide spectrum of psychiatric disorders, cognitive disorders, behavioral, emotional disorders and executive function disorders (decision-making, moral behavior and planning skills).

Children with epilepsy have a significant risk for cognitive impairment. Cognitive disorders are due to the factors that cause epilepsy and depend on the localisation of epileptic focus, the propagation of the epileptic discharge as well as on the duration and severity of the epileptic process.

A variety of co-morbid psychiatric conditions have been frequently identified in children and adolescents with epilepsy, including: depression, anxiety, psychosis and attention disorders with hyperactivity (AHDH).

The roots of neuropsychological assessment link neurology to psychiatry. Among the neuropsychological test batteries, the Cambridge Automated Testing Battery (CANTAB) allows a good cognitive assessment of the patients with neurological and psychiatric disorders, analysing visual perception, immediate and delayed memory, the executive functions and the cognitive/psycho-motor reaction speed.

We used tasks from the CANTAB battery validated for the assessment of cognitive functions with children suffering from frontal lobe and temporal lobe epilepsies. The following neuropsychological functions have been assessed: motor and global understanding abilities (Motor Screening – MOT); visual discrimination abilities - visual attention (Big/Little Circle – BLC); the ability to associate a visual stimulus with its location targeting visual memory and learning (Paired – associated learning – PAL); Spatial working memory (Spatial span – SSP); spatial recognition (SRM); recognition of certain visual patterns (PRM); identification of immediate or delayed perceptual matching (delayed matching to sample – DMS). The cognitive assessment included an IQ test, too, measured with the help of a Raven Progressive Matrices Test.

The results of this assessment establish possible cognitive phenotypes for frontal and temporal lobe epilepsy. Thus, children with frontal lobe epilepsy had a dysexecutive syndrome (frontal lobe syndrome) that associates an impairment of planning functions, with lack of inhibition, hippocamianic episodes, impulsiveness and antisocial behaviour or depression, apathy, negligence about personal appearance and perseveration. On the other hand, children with temporal lobe epilepsy had, before and after surgery, psychiatric disorders such as: disruptive behaviour disorders (ADHA/hyperkinesias, oppositional defiant disorder); emotional disorders (including anxiety and depression); social communication disorders (including autism, Asperger syndrome, pervasive developmental disorders); other major psychiatric disorders include psychosis, eating disorders and twitches.

Repeated assessments with neuropsychological testing battery, allowed us a longitudinal evaluation of the cognitive performance in epileptic children, in order to appreciate the efficiency of the therapy with antiepileptic drugs.

The advantages of the computerised neuropsychological assessment have to be pointed out because it allows a level of accuracy that is difficult for psychologists to achieve with traditional tests.

**Key words:** epilepsy, child, cognitive assessment, CANTAB battery, cognitive disorders

The epileptic process is associated with a wide spectrum of mental disorders: mental retardation, secondary autism, pervasive development disorders, epileptic psychosis, attention deficit and hyperactivity disorder, conduct disorder, affective and emotional disorders, cognitive impairment, etc. Psychiatric disorders are due to factors which generate epilepsy and relate with localisation epilepsy focus, with the propagation track of the epileptic discharge as well as with the duration and severity of the epileptic process.

Convinced that the relation between epilepsy and psychic disorders have many unknowns and that in medical practice the assistance of epilepsy follows insufficient the mental state of patients, necessary for the good evolution of seizures and for the recovery and the improvement of quality of life, we look for instruments of highlighting the suffering of mental tools, and more about the indication of secondary effects on the cognition.

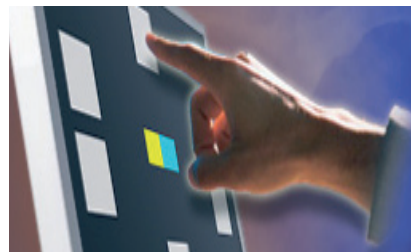
Cognition results from the amount of information contained in the mental field at one time and from their dynamic ordering with the aim of adjustment and appropriate integration into the environment.

Cognitive processes (sensation, perception, thinking, intelligence, memory, attention, language) fulfil the knowledge function through differentiation, identification, classification, abstraction, generalization, interpretation, explanation, decision making, provision, etc...

The roots of neuropsychological assessment link the two specialties: neurology and psychiatry. Neuropsychological studies aim at assessing the skills and failure of such skills in different areas of cognition: memory, attention, language, visual-spatial functions, executive function (decision making, moral behaviour and planning skills). Psychometric methods allow a more precise assessment of cognitive impairment.

Among the neuropsychological test batteries, the Cambridge Testing Automated Battery (CANTAB) is useful in cognitive assessment of patients with neurological and psychiatric disorders, analyzing visual perception, memory, short and long term executive functions and cognitive/psychomotor speed of response.

In the present study we have proposed to analyze the cognitive impairment in patients with frontal or temporal epilepsy, using CANTAB test battery (Fig. 1).



**Fig. 1:** Touch screen for CANTAB battery

CANTAB tests are computerized, non-linguistic and non-cultural. They are administered by means of an attached computer touch screen. The child touches the stimuli directly on the screen and the data listing is performed automatically.

CANTAB tests are contained in **Figure 2**.

CANTAB battery consists of the following tests:

## **1. INDUCTION TESTS:**

### **A. Motor skills and global understanding (Motor Screening - MOT):**

**Task:** The patient should finger the intermittent bright marker that appears in various locations on the screen;

**Administration time:** 3 minutes;

**Outcome:** This test has two outcome measures which measure the subject's speed of response and the accuracy of the subject's pointing.

### **B. The ability of visual discrimination (visual attention) (Big/Little Circle- BLC):**

**Overview:** The Big/Little Circle test assesses comprehension, learning and reversal. It is also intended to train subjects in the general idea of following and reversing a rule, before proceeding to the Intra/Extradimensional Shift test (IED), so it should precede the IED task in a battery.

**Task:** Subjects must first touch the smaller of the two circles displayed, then, after 20 trials, touch the larger circle for 20 further trials.

**Administration time:** around 3 minutes.

**Outcome:** The test measures the latency (the response time and the ability to choose the right circle).






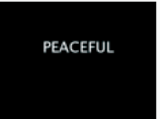

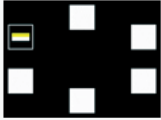
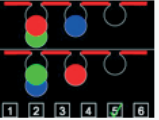
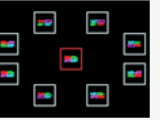
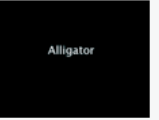




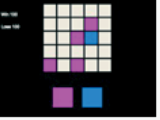


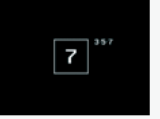

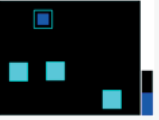

| Induction  | Visual memory   | Executive function   | Attention  | Semantic/Verbal memory  | Decision making and response control   |
|--|---|--|--|---|--|
| <br>Motor Screening (MOT)   | <br>Delayed Matching to Sample (DMS) | <br>Intra-Extra Dimensional Set Shift (IED) | <br>Choice Reaction Time (CRT)                | <br>Graded Naming Test (GNT)        | <br>Affective Go/No-go (AGN)        |
| <br>Big/Little Circle (BLC) | <br>Paired Associates Learning (PAL) | <br>One Touch Stockings of Cambridge (OTS)  | <br>Match to Sample Visual Search (MTS)       | <br>Verbal Recognition Memory (VRM) | <br>Cambridge Gambling Task (CGT)   |
|  | <br>Pattern Recognition Memory (PRM) | <br>Stockings of Cambridge (SOC)            | <br>Reaction Time (RTI)                       |   | <br>Information Sampling Task (IST) |
|  | <br>Spatial Recognition Memory (SRM) | <br>Spatial Span (SSP)                      | <br>Rapid Visual Information Processing (RVP) |   | <br>Stop Signal Task (SST)          |
|  |   | <br>Spatial Working Memory (SWM)          | <br>Simple Reaction Time (SRT)              |   |  |

Fig. 2. CANTAB Tests

## 2. VISUAL MEMORY TESTS

### A. Immediate or delayed identification of perceptual matches (Delayed matching to sample-DMS):

Overview: It tests both simultaneous and short term visual memory. This test is primarily sensitive to damage in the medial temporal lobe area, with some input from the frontal lobes.

Task: The subject is shown a complex visual pattern (the sample) and then, after a brief delay, four similar patterns. The subject must touch the pattern which exactly matches the sample.

Administration time: 10 minutes.

Outcome: It measures the speed of response, the number of correctly selected models and appreciates statistically the error probability of the response.

### B. Ability to form a series of associations between a visual stimulus and the location where it is situated (Paired-associate learning- PAL).

Overview: It assesses the learning of an association of pairs, It targets the visual memory and learning; allows the investigation of mild cognitive damage, of dementia and of memory disorders; the test is sensitive to disfunctions in middle temporal areas.

Task: Different images are displayed briefly on the screen in various locations;

Then the patient should link the centre with an image identical with the one that appeared in a peripheral location;

Administration time: 10 minutes;

Outcomes: Errors are assessed as well as the number of trials needed in order to solve the test.

### **C. Recognition of certain visual patterns**

#### **(Visual pattern recognition- PRM):**

Overview: The test investigates the ability to recognize and select the familiar stimulus in a pair;

Task: The patient is shown 12 visual models; in the next phase, the recognition phase, models are shown in reverse order, including a new model. Then the sequence is repeated with 12 new models.

Administration time: 5 minutes.

### **D. The ability of spatial recognition**

#### **(Spatial Recognition Memory - SRM):**

Overview: The test is sensitive to frontal lobe dysfunction and relatively insensitive to temporal lobe impairment;

Task: In the presentation stage, a white square is presented on the screen in 5 different locations; the patient memorizes the locations; in the recognition phase, the square reappears in each of the 5 locations as in the stage of presentation, but in reverse order, paired with an identical distracter square in locations unused during the presentation stage; the patient should ignore the distracter square; the test is repeated 3 times in 5 new locations;

Administration time: 5 minutes.

Outcomes: The test considers the number and the percentage of correct results as well as the patient's speed of response.

## **3. EXECUTIVE FUNCTIONS**

### **A. Switching attention**

#### **(Intra-Extra Dimensional Set Shift - IED):**

Overview: The test examines the visual discrimination, attention maintenance, switching and flexibility; This test is primarily sensitive to changes to the fronto-striatal areas of the brain.

Task: The subject is shown simple visual stimuli (white lines or colored areas) and compound stimuli (colored areas and white lines), initially intra-dimensional and later extra-dimensional; after 6 correct answers, the stimuli and the rules change.

Outcome: The test assesses errors, and numbers of trials and stages completed.

### **B. One Touch Stockings of Cambridge - OTS:**

Overview: One Touch Stockings of Cambridge is a spatial planning test which gives a measure of frontal lobe function. It places greater demands on working memory as the subject has to visualise the solution

Task: The patient is shown some colored balls stacked in columns; out of 1, 2, 3 or 4 moves, the patient should change their position according to a model.

Execution time: 10 minutes.

Outcomes: The test measures: problems solved on first choice, mean choices to correct, mean latency to first choice and mean latency to correct. Each of these

measures may be calculated for all problems, or for problems with a specified number of moves (1-move to 5 or 6 moves).

### **C. Stockings of Cambridge - SOC:**

Overview: It is a variant of the previous test, which considers the frontal lobe function.

Task: The patient has got two windows: in the lower one he is to arrange the colored balls according to the model in the upper window.

Execution time: 10 minutes.

Outcomes: The number of movements are measured and thus the planning ability of the subject is assessed.

### **D. Spatial working memory**

#### **(Spatial Span - SSP):**

Task: The patient is presented with a series of white boxes (2 - 9); some of them change their colour one by one in a variable sequence; the patient should touch the boxes coloured by the computer colored in the same order or in reverse order.

Execution time: 5 minutes.

Outcomes: The longest correctly memorised sequence is appreciated and the patient's errors and speed of response are recorded as well.

### **E. Spatial working memory (Spatial Working Memory - SWM):**

Overview: The test assesses the frontal lobe function and highlights executive dysfunctions,

Task: Colored squares are set to be turned in order to find full boxes which should fill column on the right.

Administration time: 8 minutes.

Outcomes: The test assesses errors, the strategy and the reaction speed.

## **4. ATTENTION**

### **A. The speed of choice**

#### **(Choice Reaction Time-CRT):**

Overview: It tests the level of concentration and the motor speed,

Task: With the help of 2 buttons, the patient marks the arrows that appear on the screen, randomly, on the right or on the left.

Administration time: 7 minutes.

Outcomes: The test estimates the number of correct and incorrect responses (omissions, commissions) and the speed of response.

### **B. Time of Response (Reaction Time - RTI):**

Overview: The test measures the subject's speed in answering the predictable or unpredictable stimuli from a visual target,

Task: Depending on the execution stage, the patient presses a pedal or the computer screen (touch screen) at the occurrence of the yellow stimulus on the screen.

Administration time: 5 minutes.

Outcome: The test estimated the reaction time and movement time.

### C. Sustained visual attention (Rapid Visual Information Processing – RVP):

Overview: The test is sensitive to parietal and frontal lobe dysfunction.

Task: Patient detects target sequence of numbers from 2 to 9, (2, 4, 6; 3, 5, 7; etc...) which occur in a random order, at a rate of 100 digits per minute.

Execution time: 7 minutes.

Outcome: The speed of response and the number of good and wrong answers are estimated

We applied tasks of the CANTAB tests to a group of 4 children with epilepsy.

### Case 1: BV, Diagnosis: frontal epilepsy

Clinical data: Male patient, aged 7 years and 2 months, repeatedly hospitalized in Cluj Napoca NP Clinic. since the age of 3 years and 9 months; he presented partial right motor seizures, (myoclonus of the chin, straight right mouth angle, upper limb: the seizure lasted for 10 to 20 seconds; consciousness maintained or slightly lost; insignificant AHC, APP. General physical examination and on devices: normal. Neurological examination: without pathological neurological signs. EEG - irritation focal aspect (sporadic spikes in the FCP derivatives on the left). Cranial CT: bilateral frontal-parietal discrete cerebral atrophy. MRI: brain without pathological aspects. Seizures could not be controlled with various antiepileptic drugs: VPA, VPA+CBZ, VPA+PHT, CBZ+VPA+TPM, CBZ+Ospolot, cures of Synachtene associate, Gamaglobuline i.v. The diagnosis was Symptomatic Focal Epilepsy uncontrolled by drugs. Functional brain imaging (PET – Methionin) was per-

formed in a clinic in Vienna: Aspect of fetal type II cortico-sub-cortical (Palmini). The epileptic source was removed surgically; postoperative right flaccid hemiparesis, resolved after 7 days. Post surgery treatment with trileptal 36mg/kg/day; the patient was free of seizures during the last year. Final Diagnosis - Symptomatic frontal epilepsy ; type II cortical – sub cortical dysplasia (Palmini).

### PSYCHOLOGICAL ASSESSMENT:

Overall performance obtained with the Standard Progressive matrices test reveals an intellect below the average. Note on the qualitative behaviour: during the first tests at the age of 5 years, the patient had marked psychomotor instability, with difficulty to maintain his attention focused. At the second evaluation, at the age of 6 years, the patient had attention difficulties but with a marked slowness of the responses and of thinking. The third evaluation took place at the age of 7: the patient's attention difficulties remained, but self-control behaviour was better, he managed to perform more tests from CANTAB battery, keeping a motor restlessness, hyperkinesias; unstabilised lateralization. CANTAB cognitive evaluation shows poor performance in certain areas:

**Evaluation 1:** MOT: average errors increased (> 2 standard deviations from the normal average) = deficits in motor skills (dyspraxia). PRM: the percentage of correct choices (> 2 standard deviations from the normal average) = deficits in visual memory. SRM: spatial recognition ability is below average but within normal limits. SSP: spatial working memory capacity is average. BLC: increased latency in visual attention (standard score = 3.27) = deficits in visual attention. (Fig. 3)

**Evaluation 2:** MOT: average errors increased (> 2 standard deviations from the normal average) = deficits in motor skills (dyspraxia). PRM: the percentage of correct choices (> 2 standard deviations from the normal average) = deficits in visual memory, increased latency in thinking (standard score = 6.63) = latency marked. SRM: spatial recognition ability is low (standard score = 2.40) = deficits in spatial recognition. SSP: spatial working memory capacity is below average (standard score = 1.43). BLC: increased latency in visual attention (standard score = 3.27) = deficits in visual attention. (Fig. 4)

**Evaluation 3:** MOT: average errors increased (> 2 standard deviations from the normal average) = deficits in motor skills (dyspraxia). PRM: the percentage of correct choices (> 2 standard deviations from the normal average) = deficits in visual memory. SRM: spatial rec-

| Test | Measure              | Raw score | Standard score | Standard score chart | Better than | Good as or better than | Population diagram | M/F | N  |
|------|----------------------|-----------|----------------|----------------------|-------------|------------------------|--------------------|-----|----|
| MOT  | Mean error           | 13.73     |                |                      |             |                        |                    |     |    |
|      | Mean latency         | 1,073.1   | -0.30          |                      | 32%         | 32%                    |                    | M   | 85 |
| PRM  | Percent correct      | 41.67     | -2.54          |                      | 2%          | 2%                     |                    | M   | 81 |
|      | Mean correct latency | 2,708.4   | -0.71          |                      | 19%         | 19%                    |                    | M   | 81 |
| SRM  | Percent correct      | 50.0      | -1.44          |                      | 10%         | 11%                    |                    | M   | 80 |
|      | Mean correct latency | 3,423.2   | -1.15          |                      | 7%          | 7%                     |                    | M   | 80 |
| SSP  | Span length          | N/A       |                |                      |             |                        |                    |     |    |
|      | Total errors         | 5         | 1.39           |                      | 94%         | 90%                    |                    | M   | 74 |
|      | Total usage errors   | 4         | -0.39          |                      | 24%         | 39%                    |                    | M   | 74 |
| BLC  | Percent correct      | 100.0     | 0.31           |                      | 9%          | 100%                   |                    | M   | 63 |
|      | Mean correct latency | 1,820.98  | -3.27          |                      | 1%          | 1%                     |                    | M   | 63 |

Fig. 3: (CANTAB) Test results I, in patient CV

ognition ability is low (standard score = 2.08) = deficits in spatial recognition. SSP: spatial working memory capacity is below average (standard score = 1.43). BLC: increased latency in visual attention (standard score = 3.27) = deficits in visual attention. DMS: identification of perceptual matches immediately below the mean (standard score = 1.83). PAL: deficits in visual memory and learning ability (standard score = 3.22) (Fig. 5)

The comparative results of the three tests are listed in Table I.

### Case 2: FA, Diagnosis: frontal epilepsy

Clinical data: female patient, aged 12 years, had repeated hospitalisations since the age of 6 for left motor partial seizures, secondarily generalized, and school difficulties. She has no significant personal history. AHC: sister with familial hypo-phosphatemia rickets. Clinical exam: changes due to severe rickets. Negative neurological examination. EEG: irritation focus in the right frontal region. She was diagnosed with frontal lobe epilepsy. She had different schemes with antiepileptic drugs: CBZ, CBZ+VPA, LTG+TPM, LTG+PHT, LTG+PHB+PHT.

| Subject ID    | BV  | Sex                | M                       |                      |             |                        |                    |     |    |
|---------------|---|--------------------|-------------------------|----------------------|-------------|------------------------|--------------------|-----|----|
| Subject notes | QI (Raven)=80; instabile psihomotorie; deficit atentional |                    |                         |                      |             |                        |                    |     |    |
| Age           | 6   | Session start time | May 24, 2007 2:59:39 PM |                      |             |                        |                    |     |    |
| Test          | Measure   | Raw score          | Standard score          | Standard score chart | Better than | Good as or better than | Population diagram | M/F | N  |
| MOT           | Mean error  | 12.44              |                         |                      |             |                        |                    |     |    |
|               | Mean latency  | 1,343.7            | -1.19                   |                      | 10%         | 10%                    |                    | M   | 85 |
| PRM           | Percent correct   | 37.5               | -2.80                   |                      | 1%          | 2%                     |                    | M   | 81 |
|               | Mean correct latency                                      | 6,094.44           | -6.63                   |                      | 0%          | 0%                     |                    | M   | 81 |
| SRM           | Percent correct   | 35.0               | -2.40                   |                      | 1%          | 1%                     |                    | M   | 80 |
|               | Mean correct latency                                      | 3,130.0            | -0.82                   |                      | 12%         | 12%                    |                    | M   | 80 |
| SSP           | Span length   | 3                  | -1.43                   |                      | 5%          | 13%                    |                    | M   | 74 |
|               | Total errors  | 8                  | 0.89                    |                      | 75%         | 83%                    |                    | M   | 74 |
|               | Total usage errors  | 3                  | 0.09                    |                      | 39%         | 56%                    |                    | M   | 74 |

Fig. 4: (CANTAB) Test results II, in patient CV

| Subject ID                           | BV  | Sex                | M                        |                      |             |                        |                    |     |    |
|--------------------------------------|---|--------------------|--------------------------|----------------------|-------------|------------------------|--------------------|-----|----|
| Subject notes                        | QI (Raven)=80; instabile psihomotorie; deficit atentional |                    |                          |                      |             |                        |                    |     |    |
| Age                                  | 7   | Session start time | Mar 20, 2008 10:13:58 AM |                      |             |                        |                    |     |    |
| Test                                 | Measure   | Raw score          | Standard score           | Standard score chart | Better than | Good as or better than | Population diagram | M/F | N  |
| MOT                                  | Mean error  | 11.2               |                          |                      |             |                        |                    |     |    |
|                                      | Mean latency  | 1,012.4            | -0.10                    |                      | 34%         | 34%                    |                    | M   | 85 |
| PRM                                  | Percent correct   | 37.5               | -2.80                    |                      | 1%          | 2%                     |                    | M   | 81 |
|                                      | Mean correct latency                                      | 2,426.89           | -0.22                    |                      | 33%         | 33%                    |                    | M   | 81 |
| SRM                                  | Percent correct   | 40.0               | -2.08                    |                      | 1%          | 5%                     |                    | M   | 80 |
|                                      | Mean correct latency                                      | 2,334.75           | 0.08                     |                      | 40%         | 40%                    |                    | M   | 80 |
| DMS                                  | Percent correct (all delays)                              | 60.0               | -0.43                    |                      | 27%         | 38%                    |                    | M   | 36 |
|                                      | Percent correct (simultaneous)                            | 80.0               | -1.83                    |                      | 2%          | 14%                    |                    | M   | 35 |
|                                      | Prob error given error                                    | 0.33               | -0.29                    |                      | 39%         | 39%                    |                    | M   | 33 |
| SSP                                  | Mean correct latency                                      | 4,833.23           |                          |                      |             |                        |                    |     |    |
|                                      | Span length   | 3                  | -1.43                    |                      | 5%          | 13%                    |                    | M   | 74 |
|                                      | Total errors  | 11                 | 0.38                     |                      | 56%         | 64%                    |                    | M   | 74 |
| PAL                                  | Total usage errors  | 4                  | -0.39                    |                      | 24%         | 39%                    |                    | M   | 74 |
|                                      | Total errors (adjusted) <sup>1</sup>                      | 111                | -3.22                    |                      | 1%          | 1%                     |                    | M   | 60 |
|                                      | First trial memory score <sup>1</sup>                     | 11                 | -2.12                    |                      | 1%          | 3%                     |                    | M   | 60 |
|                                      | Mean errors to success <sup>1</sup>                       | 6.83               | -2.21                    |                      | 1%          | 1%                     |                    | M   | 60 |
|                                      | Stages completed on first trial <sup>1</sup>              | 5                  | -0.21                    |                      | 8%          | 16%                    |                    | M   | 60 |
| Total trials (adjusted) <sup>1</sup> | 27  | -1.86              |                          | 3%                   | 3%          |                        | M                  | 60  |    |

<sup>1</sup> Subject failed

Fig. 5: (CANTAB) Test results III, in patient CV

Table I: Results of comparative CANTAB testing in patient CV

| Tests  | 5 years old       | 6 years old       | 7 years old   |
|--|-------------------|-------------------|---------------|
| Motor skill MOT  | deficits          | deficits          | deficits      |
| Visual memory PRM prefrontal                             | deficits          | deficits          | deficits      |
| Spatial recognition SRM frontal                          | below average     | deficits          | deficits      |
| Spatial working memory frontal SSP                       | the average       | below average     | below average |
| Visual attention BLC prefrontal                          | deficits          | deficits          | deficits      |
| Matches perceptual identification DMS temporal + frontal | could not perform | could not perform | below average |
| Visual memory and learning capacity PAL time             | could not perform | could not perform | deficits      |

Currently receives CBZ+TPM - without seizures for 1 ½ year;

Final diagnosis: epilepsy with motor partial left frontal seizures, instrumental problems (dyscalculia), amnesia disorder, school difficulties, and familial hypo-phosphatemia rickets. She had 2 assessments at 9 years and 10 years. Overall performance obtained with the Standard Progressive Matrices Test reveals a laminar intellect IQ= 87.

First CANTAB assessment revealed the following (Fig. 6).

**BLC:** average latency higher (> 2 standard deviations from the average normal) = deficits in visual attention; **DMS:** performance on the delayed version of identifying perceptual correspondences was more severely affected (> 2 standard deviations); in the version of identifying the immediate perceptual correspondences the results are below average (<2 standard deviations); **IED:** the number of errors, omissions and completed stages is high (> 2 standard deviations from the average normal) = deficits in the acquisition of rules and in commutation of attention processes;

**MOT:** increased latency of movement (> 2 standard deviations from the average); **PAL:** the ability to form a series of associations between a visual stimulus

and the location where it was placed revealed a pronounced deficit (number of errors, completed stages > 2 standard deviations from the average); **PRM:** poor recognition of visual patterns (> 2 standard deviations from the average), **SRM:** poor spatial recognition (> 2 standard deviations from the average); **SSP** and **SWM:** sequential memory and working memory and strategy used are average

Second CANTAB assessment revealed the following (Fig. 7).

**BLC:** average latency high (> 2 standard deviations from the average normal) = deficits in visual attention; **DMS:** performance on delayed version of the sample matches the perceptual identification and the results are immediate option below average (<2 standard deviations); **IED:** results of the number of errors, omissions and completed stages are average (<2 standard deviations from the average normal); **MOT:** increased latency of movement (> 2 standard deviations from the average); **PAL:** the ability to form a series of associations between a visual stimulus and the location where it appeared are at the average limit (number of errors, completed stages <2 standard deviations from the average); **PRM:** poor recognition of visual patterns (> 2 standard deviations from the average), **SRM:** poor

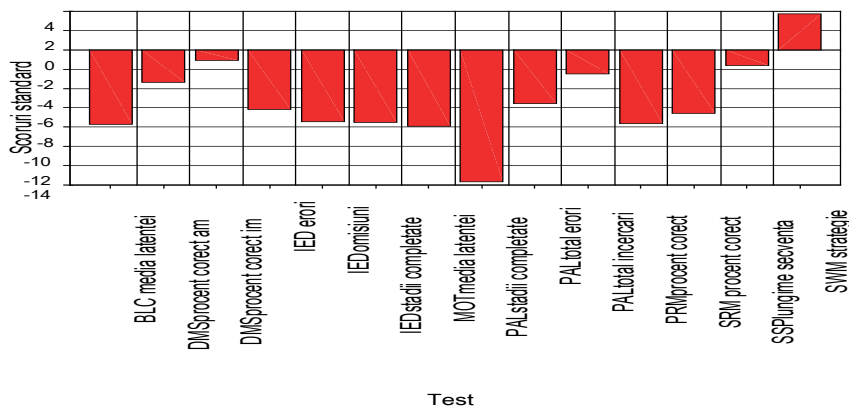


Fig. 6: Results of (CANTAB) test 1 in patient FA

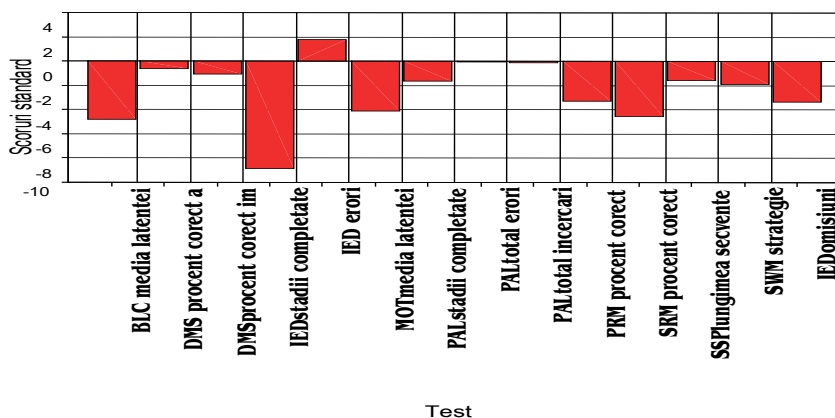


Fig. 7: Results of (CANTAB) test 2 in patient FA

spatial recognition (> 2 standard deviations from the average); SSP and SWM: sequential memory and working memory and strategy used are below average (<2 standard deviations from the average);

The results of both tests are listed in **Table II**.

**Case 3:** KG, diagnosis: temporal epilepsy

Clinical data: Patient male, aged 13 years, living in rural areas. Father with seizures in childhood, currently without treatment, without seizures. APP: insignificant. Since he was 6 years old, he has had seizures in sleep, cap gaze chewing automatisms, oral cavity deviated to the left, hyper-salivation, tonic contractions of the limbs, duration 3 - 4 minutes. Negative neurological examination. EEG: focal irritation in the right PT. Cranial CT: images suggesting small symmetrical subdural hematoma. MRI: brain asymmetry VLD VLS. Subsequently, MRI shows right hippocampus sclerosis. It was interpreted as epilepsy and the patient received VPA, and VPA + CBZ, and CBZ, as monotherapy, and he was 3 years free of seizures. In an attempt to AED withdrawal, crises reoccur. Oxcarbazepine treatment is introduced, in which seizures were controlled during the past year. Final

diagnosis: temporal lobe epilepsy with complex partial seizures during sleep (control treatment). Right hippocampus sclerosis. Liminar intellect.

Neuropsychological Assessment

Raven Standard Progressive Matrices (IQ = 85);

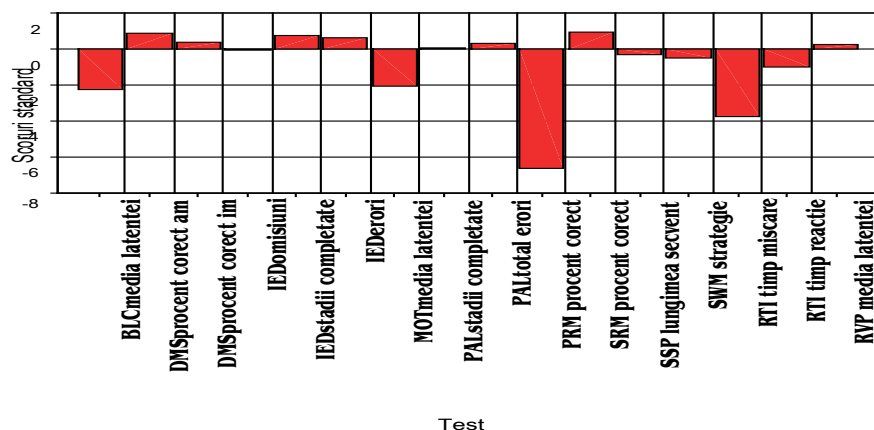
Two CANTAB reviews at 10 years and 10.6 years.

First CANTAB assesment revealed the following (**Fig. 8**).

BLC: average latency high (> 2 standard deviations from the average normal) = deficits in visual attention; DMS: performance on immediate and delayed version of sample identification perceptual matches is above average; IED: the number of errors, omissions and completed stages, on average, MOT: increased latency of movement (> 2 standard deviations from the average); PAL: the ability to form a series of associations between a visual stimulus and the location where it was, did not reveal deficits (number of errors, the stages completed on average); PRM: recognition of visual patterns, poor (> 2 standard deviations from the average), SRM: spatial recognition above the average (<2 standard deviations from the average); SSP and SWM: sequential memory and working memory and strategy used are average; RTI: during weak motion

**Table II:** Results of comparative testing in patient FA CANTAB

| Tests  | 9 years       | 10 years      |
|--|---------------|---------------|
| Visual attention BLC prefrontal                      | deficits      | deficits      |
| Matches perceptual identification time DMS + frontal | deficits      | below average |
| Switching attention fronto-striatal IED              | deficits      | the average   |
| Screening motor MOT                                  | deficits      | deficits      |
| Visual memory and learning capacity PAL time         | deficits      | below average |
| PRM temporal visual memory                           | deficits      | deficits      |
| Spatial recognition SRM frontal                      | deficits      | deficits      |
| SWM spatial working memory prefrontal                | below average | below average |
| Sequential memory prefrontal                         | the average   | the average   |



**Fig. 8:** Results of CANTAB test 1 in patient K.G.



(> 2 standard deviations); VPN: attention switching performance at average level.

Second CANTAB assessment revealed the following: (Fig. 9).

BLC: latency average lower than average (<2 standard deviations from the average normal); DMS: performance at immediate and delayed version of the sample matches the perceptual identification is slightly below average; IED: the number of errors, omissions and stages completed high (> 2 standard deviations from the average); MOT: increased latency of movement (> 2 standard deviations from the average); PAL: the ability to form a series of associations between a visual stimulus and the location where it was revealed deficits (number of errors, stages completed > 2 standard deviations from the average); PRM: poor recognition of visual patterns (> 2 standard deviations from the average), SRM: poor spatial recognition (> 2 standard deviations from the average); SSP: sequential memory are at average level, SWM: poor working memory and used strategy, (> 2 standard deviations from the average), RTI: weak motion time, (> 2 stan-

dard deviations from the average); RVP : the performance in attention switching is at the average level.

The results tests are listed in **Table III**.

**Case 4:** CV, diagnosis: temporal epilepsy (mezo-campic sclerosis)

Clinical data: male Patient, aged 18 years, without significant APP or AHC.

Since the age of 12 years he has seizures in sleep with automatism of mastication and swallowing, stertoric breathing, duration 1 min. and diurnal confusion crisis, steadiness of gaze, gesture automatism, 1-2 min duration. Neurological examination: no pathological aspects. Exam EEG: right temporal spikes solitary in derivatives. MRI: mezo-campic sclerosis. Diagnosis: symptomatic epilepsy with complex partial seizures. Disartria. Mezo-campic sclerosis. Treated with Finlepsin retard, the critical manifestations persisted; Finlepsin was replaced with Trileptal. Due to continued critical events, VPA treatment was added to the treatment, under continuous surveillance.

Neuropsychological assessment:

Raven Standard Progressive Matrices (IQ= 83);

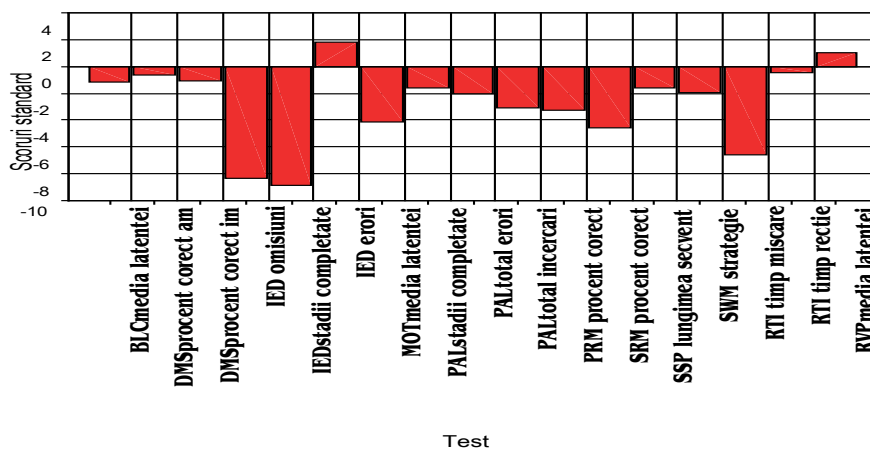


Fig. 9: Results of CANTAB test 2 in patient K.G.

**Table III:** Results of comparative CANTAB testing in patient KG

| Tests  | 10 years       | 10,6 years    |
|--|----------------|---------------|
| Visual attention BLC prefrontal                      | deficits       | below average |
| Matches perceptual identification time DMS + frontal | higher average | below average |
| Switching attention, fronto-striatal IED             | the average    | deficits      |
| Screening motor MOT                                  | deficits       | deficits      |
| Visual memory and learning capacity PAL time         | the average    | below average |
| PRM temporal visual memory                           | deficits       | deficits      |
| Spatial recognition SRM frontal                      | higher average | deficits      |
| SWM spatial working memory prefrontal                | below average  | below average |
| Sequential memory Prefrontal                         | the average    | the average   |
| RTI Response Time                                    | deficits       | deficits      |
| Switching attention VPN Prefrontal                   | the average    | the average   |

Two CANTAB reviews at the age of 15 years and of 16 years

First rating CANTAB revealed the following: (Fig. 10).

**BLC:** latency average high (> 2 standard deviations from the average normal) = deficits in visual attention, **DMS:** performance on immediate and delayed version of the sample matches the perceptual identification is poor (> 2 standard deviations from the average); **IED:** the number of errors, omissions and lower stage average, **MOT:** increased latency of movement (> 2 standard deviations from the average); **PAL:** the ability to form a series of associations between a visual stimulus and the location where it was revealed marked deficits (number of errors, stages completed > 2 standard deviations from the average); **PRM:** recognition of visual patterns, poor (> 2 standard deviations from the average), **SRM:** above average spatial recognition; **SSP:** sequential memory is average; **SWM:** working memory and strategy used is poor (> 2 standard deviations from the average);

Second CANTAB assessment revealed the following: (Fig. 11):

**BLC:** latency average high (> 2 standard deviations from the average normal) = deficits in visual attention, **DMS:** performance on immediate and delayed version of the sample matches the perceptual identification is average; **IED:** the number of errors, omissions and lower stage average, **MOT:** increased latency of movement (> 2 standard deviations from the average); **PAL:** the ability to form a series of associations between a visual stimulus and the location where it was revealed marked deficits (number of errors, stages completed > 2 standard deviations from the average); **PRM:** recognition of visual patterns on average, **SRM:** spatial recognition is poor (> 2 standard deviations from the average); **SSP:** sequential memory is poor; **SWM:** working memory and strategy used is poor (> 2 standard deviations from the average).

The results of both tests are listed in Table IV.

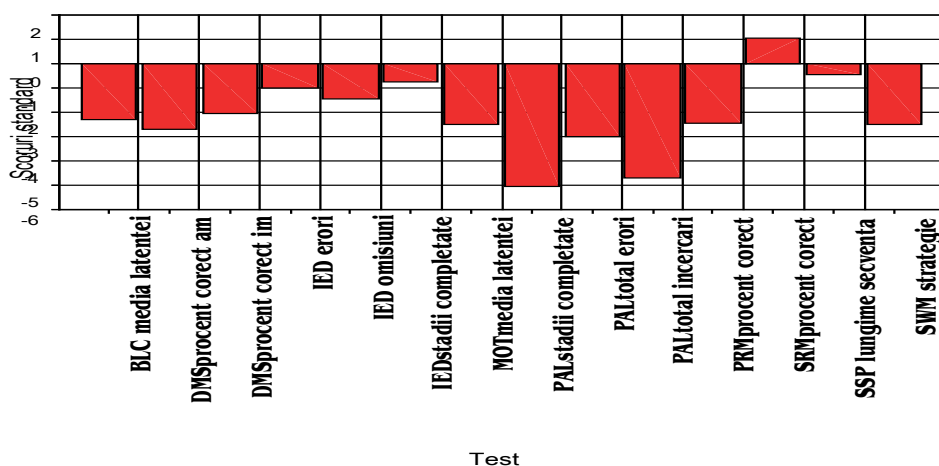


Fig. 10: First CANTAB test results in patient CV

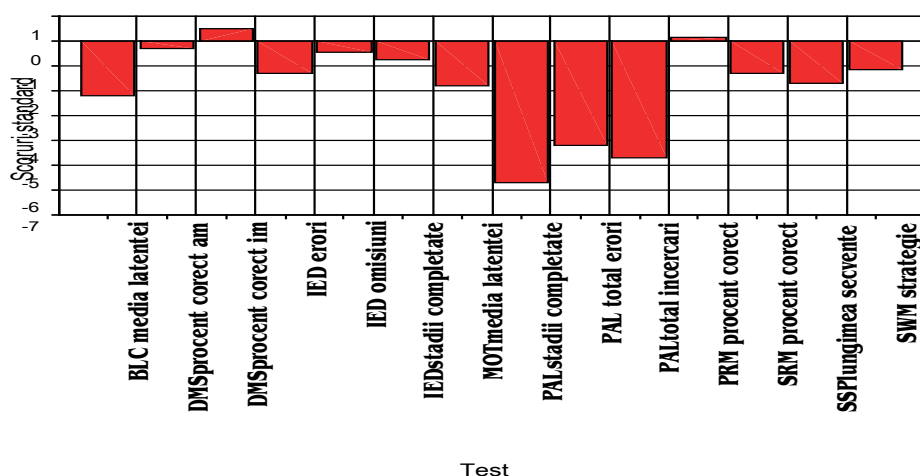


Fig. 11: Second CANTAB test results in patient CV

## CONCLUSIONS:

- Children with frontal lobe epilepsy, measured with CANTAB tests, have deficits in executive function, visual working memory and attention function;
- Children with temporal lobe epilepsy are deficient in identifying perceptual matches (DMS) and in visual memory and learning ability (PAL);

- Children with temporal lobe epilepsy may sometimes have executive dysfunction, even if this dysfunction is specific to the frontal lobe epilepsy;
- CANTAB tests bring valuable specialist information such as the traditional psychological tests can not reveal;
- Longitudinal CANTAB psychometric assessment allows better monitoring of antiepileptic treatment results.

**Table IV:** Results of CANTAB comparative testing in patient CV

| Tests   | 15 years       | 16 years      |
|---|----------------|---------------|
| Visual attention BLC prefrontal                               | Deficits       | deficits      |
| Matches perceptual identification time DMS temporal + frontal | Deficits       | below average |
| Switching attention IED fronto-striatal                       | below average  | below average |
| Screening motor MOT   | Deficits       | deficits      |
| Visual memory and learning capacity PAL time                  | Deficits       | deficits      |
| PRM temporal visual memory                                    | Deficits       | deficits      |
| Spatial recognition SRM frontal                               | higher average | deficits      |
| SWM spatial working memory prefrontal                         | deficits       | deficits      |
| Sequential memory SSP prefrontal                              | the average    | deficits      |

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