

# VERBAL AND CONSTRUCTIONAL TESTS IN EPILEPTIC PATIENTS WITH RIGHT AND LEFT HEMISPHERE FOCI

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## SUMMARY

*Abnormalities in neuropsychological tests in accordance with the epileptic focus lateralization have been continuing to be reported. In this study, we evaluated the epileptic patients with right hemispheric focus and those with left hemispheric focus, and compared them with each other and also with the age and education matched controls. The patients had either secondary generalized or simple partial or complex partial seizures without a structural abnormality except hippocampal sclerosis shown with either CT or MRI. None of the patients were mentally retarded and all had more than 5 years of education. The age range was chosen as 15-60 and there were 40 subjects in patient group and 20 in control. They were given tests of Mesulam's letter and figure cancellation, verbal memory, verbal fluency, and clock drawing. We tested whether the epileptic focus caused lateralized neuropsychological function. Patients with left hemisphere focus performed worse in verbal memory tests, and patients with right hemisphere focus on a visuo-constructional test such as clock drawing. Both groups had impairment in verbal fluency and Mesulam's verbal cancellation tests.*

**Key words:** Epilepsy, neuropsychology, verbal, memory, constructional

## ÖZET

*Epileptik fokus lateralizasyonu ile uyumlu nöropsikolojik test anormallikleri bildirilmektedir. Bu çalışmada, sağ hemisferde yada sol hemisferde fokusu olan epileptik hastaları, yaş ve eğitimleri uygun kontrollerle karşılaştırdık. Hasta grubu BT veya MRG'de hipokampal skleroz dışında yapısal lezyon görülmeyen parsiyel epilepsi olgularıyla. Hastaların hiçbirisi mental retarde değildi ve tümü 5 yıldan fazla eğitime sahipti. Yaş sınırı 15-60 yıl olarak seçildi ve kontrol grubu 20, hasta grubu 40 bireyden oluşuyordu. Olgulara Mesulam'ın şekil ve harf iptal testi sözel bellek, sözel akıcılık, saat çizme testleri uygulandı. Olgularda epileptik odakla uyumlu lateralize nöropsikolojik defisit saptandı. Sol hemisferik odaklı olgular sözel bellek testlerinde, sağ hemisfer odaklı olgular saat çizme gibi görsel-konstrüksiyonel testlerde daha kötü performans gösterdiler. Ancak her iki grup da sözel akıcılık ve Mesulam'ın harf iptal testinde kontrollere göre daha başarılıydı.*

**Key words:** Epilepsi, nöropsikolojik test, sözel bellek

Cognitive abnormalities shown with neuropsychological tests have been reported in epileptic patients. The effects of the epileptic focus to the lateralized neuropsychological tests have still been investigated (1,2,3,4). Detecting these abnormalities may be useful in estimating prognosis of surgical outcome in epileptics (5) and may help to lateralize focus (6). Verbal abilities are main function of the left hemisphere

and constructional abilities of the right hemisphere (7). As commonly seen in stroke patients, left hemisphere lesions result in aphasia and right hemisphere lesions in the neglect of contralateral hemispace or body half (8). Even though the effects of destructional lesions are well known, there are still controversies on the effects of a non-structural, chronic, irritative phenomenon, such as an

epileptic focus. Most of these studies agree that verbal abilities are worse in patients with left hemisphere lesions (LHF), whereas spatial abilities are worse in patients with right hemisphere focus (RHF) than controls (1,3,4,9,10). We aimed to investigate if the epileptic focus lateralization is related to corresponding cognitive dysfunction. We hypothesized that LHF group would perform worse than controls in verbal tests and RHF group in constructional tests. Using a battery of neuropsychological tests on patients of focal epilepsy with seizures originating from either hemisphere, we aimed to examine their neuropsychological features.

#### MATERIAL and METHOD

**Subjects:** Patients were chosen in registration order among 728 epileptic patients who are followed at the Dokuz Eylül University Hospital, Epilepsy Clinic of Neurology Department. Patients had either secondary generalized or simple partial or complex partial seizures without a structural abnormality shown with CT or MRI. There were 20 patients with RHF, 20 with LHF, and 20 age and education matched controls. Controls were healthy volunteers, chosen from hospital workers or caregivers of patients. Patients' interictal EEG

demonstrated localized epileptic abnormalities, such as sporadic spike and sharp, spike and wave, or localized paroxysmal rhythmic slow waves either in right or left hemisphere. Duration of epilepsy ranged between 1-36 years. 11 patients had epilepsy for less than 5 years, 11 for 6-10, 15 for 11-20 and 2 for more than 21 years. Twenty two of 40 patients were seizure-free and 14 had seizures 1-10 times per year and 4 had more than 11 seizures per year. The focus sites were right parieto-occipital in 2, left parieto-occipital in 1, right temporal in 10, left temporal in 9, right frontal in 2, left frontal in 2, always in right hemisphere without certain site in 6, always in left hemisphere without certain site in 8 patients. None of the subjects were mentally retarded, and all had more than 5 years of education. The age range was chosen as 15-60 years, the mean age and standard deviations were 25.7±9.3 for RHF, 30.5±10.3 for LHF, 24.5±6.2 for controls. There were one left handed subject each in control and LHF groups, 2 ambidexter and 2 left handed subject in RHF. There were 8 females and 12 males in RHF, and 12 females and 8 males in both of the LHF and control groups. The demographic features of the subjects are shown in Table I.

Table I. Demographic features of the subjects

	Age	Education (yrs)	Hand preference	Gender (F/M)
RHF (N:20)	25.7 ± 9.3	9.9 ± 3.0	2 A, 2 L, 16 R	8 / 12
LHF (N:20)	30.5 ± 10.3	9.0 ± 3.8	1 L, 19 R	12 / 8
CONT(N:20)	24.5 ± 6.2	10.5 ± 4.0	1 L, 19 R	12 / 8

RHF: Right hemisphere focus, LHF: Left hemisphere focus, A: Ambidexter, Cont: Control, F: Female, M: Male, R: Right, L: Left



Antiepileptic medication included carbamazepine monotherapy in 17, carbamazepine polytherapy in 12 (additional to lamotrigine or valproic acid, clonazepam, or primidone). Seven patients were on phenytoin monotherapy, 3 on valproic acid monotherapy, and 1 patient was about to start carbamazepine monotherapy.

Neuropsychological tests: Verbal learning, memory and recognition, verbal fluency, Mesulam's figure and letter cancellation tests, and clock drawing were administered to all subjects.

a) Verbal learning, memory and recognition; of a word list: Ten unrelated words were read by patients in three trials. After each trial, patients were asked to recite words (Verbal learning 1, 2, 3). Ten minutes later they were asked to recall these words (verbal memory). Then they were presented with 20 words, 10 of which were not shown previously. Number of correct answers to the question if the word was previously seen or not, was scored (verbal recognition). This test was developed from CERAD battery (11).

b) Mesulam's letter and figure cancellation test: Time for completing test and number of errors were recorded (8).

c) Clock drawing: Patients were constructed to draw a clock face on a given circle and then draw the hands to set the time to 11:10. Their performances were scored depending on the correct placement of numbers or hands. The scores were determined by distance from correct angle that clock hands should be placed.

d) Verbal fluency: This is evaluated by animal naming, a subtest of Boston Diagnostic Aphasia Test, that measures semantic verbal fluency, or the capacity to retrieve words from a given category from remote memory. The patients was asked to produce as many names of animals as possible in a minute. The number of animals cited in a minute were taken as score.

Statistical analysis: RHF and LHF group and control subjects were compared using ANOVA test (Statview program). P values less than 0,05 were accepted as significant.

## RESULTS

### 1. Verbal tests:

a) Verbal learning, memory and recognition: LHF group scored worse in verbal learning, memory and recognition than RHF and controls. There was no significant difference between RHF and controls.

b) Verbal fluency: LHF scored worse than RHF and controls. RHF group performance was also lower than controls.

2. Mesulam's Letter and Figure Cancellation tests: Both patient groups needed more time than controls to complete letter cancellation test. However, error rate was significantly higher than controls only in RHF group. In figure cancellation test, LHF finished the test later than controls, however there was no difference from controls in number of errors.

3. Clock drawing: RHF scored worse than LHF and controls. LHF did not differ significantly than controls.

Results were given in Tables 2 and 3.





11 : 10

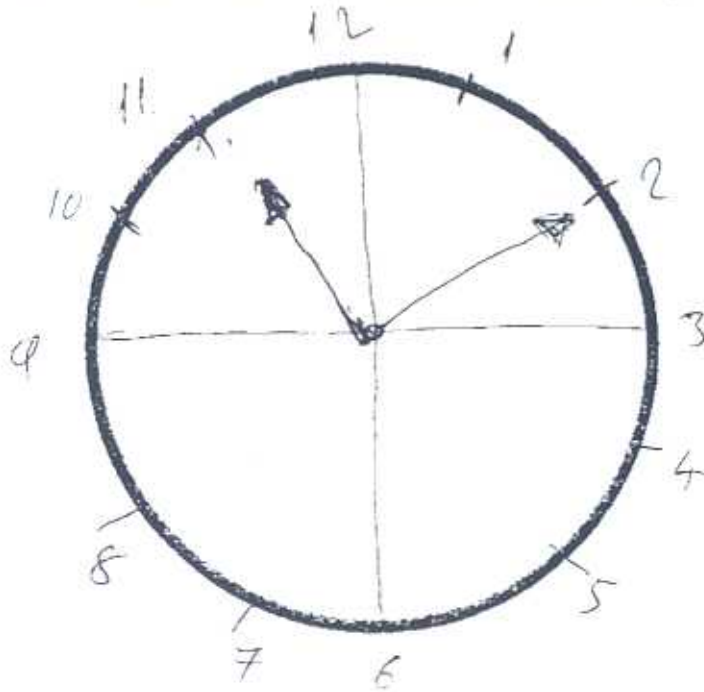
SOZEL AKICILIK TESTİ

1 Dakıkada aklınıza gelen hayvan isimlerini sayınız:

28/11

ilk 15 saniye	15-30 saniye	30-45 saniye	45-60 saniye

Figure 2. Clock drawing and verbal fluency test in a patient with right temporal focus and 11 years of education (same patient in Figure 1). Constructional ability is decreased, but verbal fluency is within normal limits.



11 : 10

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Figure 3. Clock drawing and verbal fluency test in a patient with left temporal focus and 11 years of education. Constructional ability is well, but verbal fluency is lower than normal controls.

**Table II.** Means ± standard deviations for neuropsychological test scores.

	RHF	LHF	Controls
Verbal learning 1	6.0±0.8	5.1±1.2	6.1±1.4
Verbal learning 2	7.4±1.2	6.9±1.5	7.7±1.3
Verbal learning 3	8.7±0.8	7.6±1.1	8.7±0.8
Verbal memory	7.4±1.5	6.4±1.6	8.3±1.1
Verbal recognition	19.7±0.6	19.0±1.3	19.9±0.4
Verbal fluency	20.4±5.1	13.3±4.8	24.7±6.2
Clock drawing	3.3±1.4	4.2±1.1	4.9±0.4
Time for figure cancellation	128.0±51.0	146.0±48.0	97.0±16.0
Time for letter cancellation	133.0±41.0	158.0±52.0	99.0±16.0
Error in figure cancellation	0.8±2.0	1.1±2.7	0.3±0.5
Error in letter cancellation	2.1±2.5	1.2±1.1	0.4±1.1

RHF:Right hemisphere focus, LHF: Left hemisphere focus

**Table III.** Neuropsychological test difference probabilities. P values less than 0.05 were accepted as significant. (ANOVA test)

	RHF and LHF	RHF and Controls	LHF and Controls
Verbal learning 1	0.037 *	0.72	0.02 *
Verbal learning 2	0.23	0.53	0.09
Verbal learning 3	0.0008 *	0.92	0.0013 *
Verbal memory	0.037 *	0.073	0.0005 *
Verbal recognition	0.013 *	0.72	0.0098 *
Verbal fluency	0.0004 *	0.032 *	<0.0001 *
Clock drawing	0.024 *	0.0004 *	0.11
Time for figure cancellation	0.22	0.055	0.0038*
Time for letter cancellation	0.067	0.022 *	0.0002*
Error in figure cancellation	0.68	0.48	0.28
Error in letter cancellation	0.14	0.012 *	0.23

p<0.05 values were shown with (\*). RHF:Right hemisphere focus, LHF: Left hemisphere focus

## DISCUSSION

The findings of the present study provide more evidence that neuropsychological abnormalities can be encountered in focal epileptic patients without a structural lesion (1,4). Laterality effects of temporal lobe epilepsies in memory and other neuropsychological tests are continuing to be a controversial issue. Loiseau et al. (1983) could not find any difference in memory tests in temporal lobe-epilepsy patients, but they found worsened memory in generalized

epilepsy subjects. Durwen and Elger (1993) blamed antiepileptics for lateralized cognitive dysfunction, when drug doses were reduced, they found no difference in verbal test performance between patients with left or right hemisphere focus (12). Mayeux et al (1980) explicitly stated that no significant difference was seen between patients with left versus right temporal foci with respect to verbal memory or visual reproduction (13). However in that study, patient population was not compared to healthy



controls, so they were unable to establish the impairment in their limited patient sample. Impaired non-verbal memory in right temporal lobe epilepsy group has been reported by Giovagnoli et al (1995) (14). Hermann et al (1992) reported that absence or mild hippocampal sclerosis was associated with greater postoperative impairment of both verbal and figural memory, yet found no statistically significant difference in right temporal lobectomy group (15). Another conflicting result was reported by Sass et al (16) in medically refractory epilepsy patients localized to temporal lobe, impaired verbal memory existed regardless of the lateralization of the seizure focus, but it was most severe for patients with left temporal seizure foci. Most consistently, other studies with larger series of patients implicated a role for left mesial temporal lobe structures in verbal memory (9,10,15,17-22). Also degree of memory performance was correlated with hippocampal pyramidal cell density in resected tissue (21) or magnetic resonance imaging-based measures of hippocampal volume reduction (23,24). Distinct laterality-specific cognitive impairments, i.e. non-verbal memory, have been associated with right sided medial temporal lobe epilepsy in fewer numbers of studies (14,25).

In our study, most of the neuropsychological test abnormalities were accordant with focus laterality. Patients with left hemispheric focus (LHF) performed worse than those with right hemispheric focus (RHF) in verbal learning, memory, recognition, and fluency, whereas RHF

group scored lower than LHF group in clock drawing and Mesulam's letter cancellation test. Also, both patient groups performed worse than controls in verbal fluency and Mesulam's letter cancellation tests. Among the neuropsychological tests, abnormalities in verbal fluency tests that imply left frontal lobe function were more prominent than verbal memory tests in both patient groups. This finding is somewhat contradictory to our hypothesis of lateralization of neuropsychological dysfunction. Hermann et al (1997) also found that laterality of seizure was not associated with verbal fluency (25). Mesulam stated that mental function lateralization is less prominent in epileptic patients than healthy controls due to chronic changes in brain organisation (8). Another explanation for not seeing laterality in some of these tests can be discordant interictal scalp EEG recordings with depth electrode recordings by a rate of 12% (26). Since our population was based on interictal scalp recordings only, a small number of our patients may be misclassified, thence resulting in less laterality effect of neuropsychological tests.

Mesulam's figure cancellation tests show that LHF group completes the test without difference in error rate, but they need more time for completion of the test. In letter cancellation, both of the patient groups finish the test later than controls. RHF group completes the figure cancellation test in similar time, but their error rate is significantly higher. From these results, one can speculate that LHF group is more attentive to what they do than RHF group. In

that, our finding shows parallel to study of Pyle et al (1995), in which they found LHF group shows slower performance on the visual search tasks, despite similar level of accuracy (27).

The neuropsychological test results in the literature have been reported discrepant with each other, but the role of left medial temporal lobe in verbal memory has been implicated most consistently in temporal lobe epilepsy patients without structural lesion or those after

lobectomy. Our findings indicated laterality in neuropsychological tests of patients with focal epilepsy, since patients with left hemispheric foci displayed impairment in verbal learning, memory and recognition, and those with right hemispheric foci in clock-drawing. Yet, verbal fluency and Mesulam's letter cancellation tests appear impaired unaffectedly from laterality effects.

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