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Divided Attention in Epilepsy

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Abstract

Selective and sustained attention deficits have been reported in epilepsy. Divided attention paradigms are comparable to real life situations but has not been studied in epilepsy. The present study examined divided attention in generalized epilepsy using a dual-task paradigm with the psychophysiological index of P300 as a measure of attentional resource. P300 was assessed on the odd ball paradigm under baseline and combined with a verbal or visual identification task. Ten patients with idiopathic generalized epilepsy were compared with ten normal controls. Attentional resource was adequate in patients. Division of attention was possible in some patients. Efficiency of division of attention was poor in patients when the primary task was difficult; but comparable too normals when the primary task was easy.

Key words -

Attention,
Cognition disorders,
Epilepsy,
Epilepsy generalized,
Neuropsychological tests

It is well established that patients with epilepsy suffer cognitive impairment. Deficits are in attention and concentration, memory, psychomotor speed, intelligence and learning [1]. Attention has three aspects, i.e., selective, sustained and divided attention. Selective attention deficits are present in generalized epilepsy [2]. Information processing tasks revealed deficits in attention and problem solving [3]. Stroop test, visual scanning tests found deficits in attention, concentration and speed of processing [4]. These deficits were greater in generalised epilepsy as compared with focal epilepsy [5]. Capacity to withstand distraction was poor in generalised epilepsy [6]. Sustained attention deficits as seen on the continuous performance test is present in generalized epilepsy [7]. Compared with partial epilepsy, sustained attention deficits were greater in generalised epilepsy [8], [9]. Divided attention deficits are present in epilepsy [10]. While selective and sustained attention deficits have been examined extensively, divided attention has received little attention. Tasks requiring cognitive processing are not performed in isolation in everyday situations. Therefore the divided attention paradigm offers a close approximation to cognitive performance in real life situations. Division of attention is possible through drawing upon attentional resources belonging to different structures, (i.e. information processing mechanisms necessary for performance). Hemisphere of processing [11], stages of processing, modalities of processing, central codes (verbal vs spatial), responses (manual or vocal) form structural composition of resource reservoirs. These "resource pools" are independent and intertask interference depends on the extent to which the two tasks both draw on the same resource pools [12]. P300 indexes stimulus evaluation and is not contaminated by response processes [13]. Dual tasks sharing perceptual and central processing resources, show resource depletion as reduction in P300 amplitude [14], [15]. Being free of contamination by response processes. P300 is a relatively pure psychophysiological measure of attentional processing resources [16].

The present study examined the nature of divided attention in epilepsy using the P300 measure. As selective and sustained attention deficits are greater in generalized epilepsy, divided attention was studied in this patient group. Attentional resource pools being specific to hemispheres of processing, division of attention within each hemisphere processing resource was studied separately using verbal and nonverbal identification tasks (i.e. primary tasks). The secondary task in either case was the auditory oddball paradigm. It was administered alone (baseline condition) and in conjunction with the primary task (dual task condition). Changes in P300 amplitude in the dual task condition when compared with the baseline condition indicated the nature and extent of division of attention.

Methods

Sample: Eight patients with primary generalized epilepsy and two patients with complex partial seizures secondarily generalized in the age range of 16 - 30 yrs (mean age 23 yrs); with seizure duration < 2 yrs, with no history of cluster attacks/status epilepticus, inter or postictal psychiatric condition, head injury or other neurological/psychiatric disorders formed the patient group. Patients were selected from out patients attending the Department of Neurology, NIMHANS. Patients had idiopathic epilepsy, were on monotherapy with phenobarbitone (pb) 60 mg. per day and seizure free for at least 3 months prior to the assessment. Ten normal volunteers in the same age range (mean age 24.9 yrs) with no history of psychiatric or neurological disorder formed the control group. Patients and normals were right handed, and no sensory deficits or clinical evidence of mental retardation and no family history of psychiatric disorder. The average education of patients was 13.1 yrs of schooling and of normal 15.1 yrs of schooling. Patients and controls did not differ significantly in age or education. There were 6 males and 4 females in each group. Informed consent was taken from patients after explaining that the study was non invasive, conducted for research purposes and would not interfere with their treatment. It was clarified that refusal to participate also would not interfere with their treatment. Normal subjects volunteered for the study after the purpose and non invasive nature of the study was explained to them.

P300 Measure: EEG was collected from PZ (10-20 system) on Medicare Polyrite amplifiers. High frequency cut off was at 35 HZ and low frequency at 1 HZ. Notch filter was used to eliminated 50 HZ artefact. Silver/silver chloride disc electrodes were used with electrode resistance being less than 5 kohms. Linked mastoids were the reference. Eye movement was recorded by fixing one electrode above and one below the right eye.

Nihon-Kohden auditory/LED visual stimulator, SMP 4100 was used to present tones for the oddball paradigm. Two tone bursts, a frequent tone (750 HZ: 80%) and an infrequent tone (1.5 KHZ: 20%) were presented binaurally through head phones in a random order. The tones were of 80 dB intensity in phase in both ears, with a 10ms rise / fall time and 100 ms plateau time. Inter stimulus interval varied randomly about a mean of 3 secs. Subject tapped the right foot at the occurrence of the infrequent tone. EEG was digitized at a sampling rate of 1/ms. using Iwatsu SM-2100B signal analyser. Averaging was done for a time window 1250 milli seconds, the first 100 ms being the pre stimulus baseline. 49 epochs to the infrequent tone were averaged to obtain the average ERP waveform for each subject. P300 component was identified as the largest positive deflection occurring between 200-600 milliseconds post stimulus [17] P300 latency was the time interval between stimulus onset and the P300 peak. P300 amplitude was calculated by algebraically subtracting the average amplitude of the prestimulus baseline from the amplitude of baseline to P300 peak. The deflection in the eye movement channel coinciding in time with the P300 peak in PZ channel was the eye movement amplitude. Eye movement artefacts were checked by computing a correlation between P300 amplitude and eye movement amplitude for each group. The correlation were insignificant. Using the above procedure ERP average waveform was obtained in the baseline condition i.e. oddball paradigm given alone. In the dual task condition the oddball paradigm was combined with each of the following primary tasks.

Primary task 1: was verbal, tapping attentional resource of the left hemisphere. 100 cards were presented tachistopically. Each card contained three common English words of 3-6 letters written one below the other. The three words belonged to the same category on 50 cards. On the remaining 50 cards one of the words belonged to a different category.

Primary task II: was figural task, tapping attentional resource of the right hemisphere. Instead of words, three abstract figures were the stimuli. In the 50 same category cards, the three figures were identical, while in the 50 different category cards, two figures were identical but one was different.

In both tasks I and II the different category word/figure occupied the first, second or third position randomly. Order of presentation was randomised over 100 trails. Each card was exposed for 500 ms, with an inter stimulus interval of 9 secs. using a Gerbrands 2 field tachistoscope. On each trial the subject pressed a button with the right thumb for different category card. Response Accuracy and reaction time were the scores. In the dual task condition, subjects were asked to pay attention too both tasks. Orders of primary task 1 & 2 were counter balanced across subjects in each group.

Results

The nature of P300 in the different conditions is given in Table I.

Table I - Nature of P300 across condition in both groups

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In the baseline condition the P300 component was present in patients and controls, i.e. in 9 patients and all the 10 controls. Chi square test did no reveal a significant difference between the groups. In the dual task condition with primary task I, significantly lesser number of subjects produced the P300 component. The reduction was significant on the fisher exact probability test at $p < .02$ level in patients and $p < .05$ level in normals. However in the dual task condition with primary task II, the reduction was not significant in either group on the Fisher's exact probability test. The effects were similar in both groups in each of the dual task conditions. The verbal and visual primary tasks were chosen to tap attentional resources from the two hemispheres. Though we designed the tasks to be of comparable difficulty, the data from this study do not support the assumption. Finding the odd picture from a group of three pictures (primary task II) was easier than finding the odd word from a group of three words (primary task I). Comparison of mean accuracy and reaction time scores in the two tasks found that both patients and normals performed more accurately and normals were faster on the primary task II

(Table II). The easier nature of the primary task II could be the reason for a equivalent number of patients and normals producing the P300 component in both the baseline and the dual task condition with primary task II.

Table II - Performance in primary tasks I and II

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Absence of the P300 component in the dual task condition signifies lack of division of attention between the oddball task and the primary task. A similar number of subjects in either group could not divide their attention, as the P300 component was absent under the dual task paradigm (Table I). As this inability was present to a similar degree in normals also, this inability was not unique to patients. Among the subjects who could divide their attention, i.e., who produced the P300 component, a decrease in P300 amplitude in the dual task condition was an index of depletion in the attentional resource. Contrary to expectation, in either of the dual task condition, the P300 amplitude did not decrease in every subject. There was a decrease in some patients/normals while there was an increase in others (Table III).

Table III - Change of P300 amplitude in the dual task conditions compared to the baseline

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Note: In Cells wherein N is greater than one mean values are depicted.

Normals tended to have decrease in P300 amplitude when the primary task was difficult, but when it was easy there were equal number of normals with increases as decreases. Very few patients produced a P300 when the primary task was difficult i.e., primary task I. Patients tended to have a decrease in P300 amplitude when the primary task was difficult i.e. primary I. The small number of subjects in either group showing these effects does not justify any meaningful conclusion about these trends. Further studies with a larger sample is required.

Patients were as efficient as normals in the stimulus evaluation process. The P300 latency and amplitude did not differ significantly between the two groups in the baseline or in either of the two dual task conditions.

Discussion

Stimulus evaluation process and attentional resources are adequate in patients with generalized epilepsy, as revealed by the lack of significant differences in P300 amplitude or latency between patients and controls, as well as by the production of P300 in all patients except one. The clinical variables of this patient were not significantly different from others. Some epileptic patients do not produce a P300 [18]. The findings contradict previous studies which report P300 abnormalities in epileptic patients in terms of increased P300 latencies [18], [19], [20], [21], [22], [23]. The clinical characteristics of patients in the studies reporting P300 abnormalities were different from those of patients in the present study. The age range was wide [23], with some patients being more than 50 yrs old [20]. Increased latencies were present in patients with temporal lobe epilepsy but not in patients with idiopathic generalized seizures [21] and in a sample with different types of epilepsies [23]. Patients with intractable complex partial seizures, mean seizure duration of 19.6 yrs and a young age of onset (11.4 years) had longer P300 latencies [18]. In contrast, patients in the present study were young, age range was restricted, seizure duration was short (less than 2 yrs), had later age of onset (not less than 14 yrs), with well controlled seizures. In line with the present study no P300 abnormalities were reported in patients with generalized epilepsy [24].

Epileptic patients are able to divide their attention between two tasks. When the difficulty level of the primary task is high as was with primary task I of the present study, resource depletion is so great that no resources are allocated to the second task in some subjects. Hence P300 component is not produced. This level of depletion is attributable to the nature of primary task and not to epilepsy. Significantly lesser number of subjects in either group produced P300 in DAPI as compared with baseline, but the number of subjects in whom P300 was absent was comparable between groups. Again this level of resource depletion did not occur in DAPII wherein the primary task was easier as reflected by higher accuracy, of performance in both groups. The greater difficulty of primary task I also led to a decrease in its performance in terms of accuracy and speed in epileptic patients as compared with normals. Thus in dual task conditions when the difficulty level of the primary task is high, performance on the primary task worsens and attentional resource to the secondary task depletes in epilepsy. But when the primary task is not difficult, epileptic patients are able to divide their attention. It is preferable to interpret the results in terms of task difficulty rather than hemisphere resources because task difficulty is confounded with hemisphere specificity of the task.

Among the subjects who do produce a P300 component in the dual task condition, there is no consistent trend towards a decrement in P300 amplitude in patients or normals. In each group P300 amplitude shows an increase in some subjects and a decrease in others. Previous studies on normals found a decrement of P300 amplitude to the secondary task in the dual task paradigm [14]. Lack of consistency of this trend could be attributed to differences in strategies of attentional allocation to the two tasks in different subjects.

The present results indicate that attentional resources are adequate in patients with generalized epilepsy whose seizures are controlled. As in normals, division of attention is possible in some patients. The efficiency of division of attention is comparable to normals, when the primary task difficulty is low, but when it is high, epileptic patients are less efficient.

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