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Memory Changes After Unilateral and Bilateral Convulsive Therapy (ECT)*

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Memory deficit persists as the principal undesirable side effect of convulsive therapy. In an attempt to minimize this deficit Lancaster, Steinert and Frost (1958) introduced unilateral electrode placement to the non-dominant hemisphere as an alternative to the standard bilateral placement of electrodes. They suggested that clinical improvement with unilateral placement was the same as for bilateral ECT, but that memory impairment was less severe.

Several studies of this issue have been conducted, with contradictory results (Cannicott, 1962; McAndrew *et al.*, 1967; Zinkin and Birtchnell, 1968). The contradictions may be related to failure to clearly define the memory tasks and to account for differences in cerebral hemispheric functioning, *i.e.* lateralization of function (dominance). The studies failed to consider either the nature of the material (verbal or non-verbal) or the input modality (auditory or visual) in evaluating ECT effects (Kimura, 1963; Milner, 1962).

In the present experiment several tasks, each more strongly associated with one hemisphere than the other, were studied after the application of either unilateral non-dominant or bilateral ECT. Two auditory verbal tasks and one visual non-verbal task were employed. We expected subjects receiving bilateral treatment to show greater impairment than those receiving unilateral treatment on auditory verbal tasks (which presumably have greater representation in the left hemisphere); and bilateral and unilateral treated subjects to show similar impairments on the visual non-verbal task, a function which presumably is lateralized in the right hemisphere.

Method

Subjects. Subjects were chosen from patients admitted for ECT to the in-patient service of a private psychiatric hospital. Patients with diagnoses of primary depressive illness were selected by the research psychiatrist (manic-depressive, depressed; involutional depressive psychosis; depressive neurosis).

The number and mean age of subjects participating in each task is shown in Table I. Assignment to treatment group was non-random.

Table I
Population characteristics

Treatment		Visual STM	Auditory STM	Wechsler PALT
Bilateral	N	23	18	23
	Mn (yrs)	64·99	64·93	65·39
	SD	7·45	7·30	9·02
Unilateral	N	17	15	18
	Mn (yrs)	61·84	64·44	65·15
	SD	14·22	5·70	9·87

Procedure. Subjects were tested prior to their first treatment and (approximately) 24 hours after their fourth or fifth treatments. During the course of ECT, attending physicians were free to prescribe antidepressant, antianxiety sedative, and neuroleptic drugs.

Before and after ECT each patient was interviewed by the research psychiatrist, who assigned a diagnosis and completed a modified Hamilton Rating Scale for depression. A 20-minute resting EEG was recorded, and the Harris Test (1958) was used to determine dominance. Where a patient displayed mixed laterality, handedness was used to determine dominance. The memory tests (see below) were then given. In the post-ECT sessions the Harris test was omitted.

ECT. A Medcraft B-24 ECT machine was used to administer bilateral treatments; the Medcraft B-24 or Reiter-Molac II for unilateral treatments. The most usual setting for the Medcraft was 160-170 volts for 0·75–1·0 sec. duration; the Reiter had no equivalent settings. The treatments were given every other day, *i.e.* Monday, Wednesday, Friday, or Tuesday, Thursday, Saturday.

ECT was given with methohexital anaesthesia and succinycholine muscle relaxation. Bilateral ECT was given through bifronto-temporal electrodes and unilateral ECT through non-dominant tempero-parietal electrodes as described by Lancaster, Steinert and Frost (1958). In all except three cases, patients were judged right-handed with left cerebral dominance and were given right unilateral ECT.

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All patients were judged to have had a grand mal seizure; if this did not occur on the first attempt a second treatment was given in the same session. Fifty per cent of the patients receiving unilateral treatment routinely were given two seizures on several occasions.

Tests

Auditory short-term memory (*ASTM*). Sixteen consonant trigrams (*e.g.* DLG) were presented by tape. Each trigram was of three seconds duration, *i.e.* one second per consonant. Patients were required to recall each trigram after intervals of 0, 6, 12 and 18 seconds—there were four trigrams at each retention interval. Both retention interval and order of presentation of trigrams were randomized.

During these retention intervals, subjects were occupied with reading a list of numbers. At the end of each interval an auditory signal was the subject's cue to recall the trigram. The score was the number of trigrams correctly recalled at each interval.

Loudness was individually adjusted for each patient; the level was such that stimuli were clearly and easily discriminable.

Visual short-term memory (*VSTM*). The material consisted of a circle of a quarter-inch diameter located at one of three positions on an 8·5 inch line. Each subject was shown the circle for two seconds and then was asked to reproduce the position of the circle on an 8·5 inch line. As in the auditory task, the subject's response was recorded after filled retention intervals of 0, 6, 12, and 18 seconds. There were three circles at each of the four retention intervals; the order of presentation of these intervals was randomized. The score was the distance in millimetres between the circle's true location and the subject's estimate.

Paired-associate learning task (*PALT*). This is a sub-test of the Wechsler Memory Scale (1945). It consists of ten paired-associate (stimulus-response) items, *e.g.* fruit—apple. After each presentation of the ten pairs, the stimulus item alone was presented and the subject was required to give the associated response. After each presentation the order of items was randomized. This procedure was repeated three times; the number of items recalled on the third and final trial was the immediate recall (IR) score. The stimulus list was presented again three hours later and the number of correct responses at this presentation was the delayed recall score (DR).

Results

This report is limited to memory measures. EEG and clinical findings have been presented elsewhere (Abrams *et al.*, 1970a, 1970b) and will be related to memory data later.

Both treatment groups were equivalent in age and pre-ECT memory performance as determined by t-tests and analyses of variance respectively. The data were analysed by analyses of variance to include comparison between pre- and post-treatment scores.

Visual short-term memory. The interaction between treatment group and retention interval was significant ($F_{3,114} = 2\cdot81$; $p < \cdot05$). At delay intervals of 6, 12, and 18 seconds, bilateral and unilateral treated subjects perform similarly. At 0 second delay, however, the disparity between bilateral and unilateral

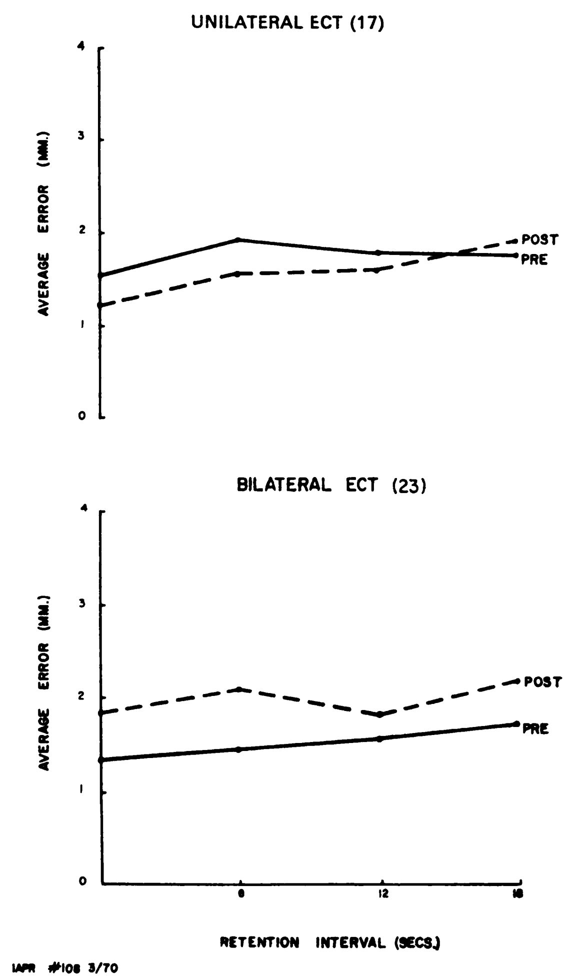

Fig. 1.

Visual short-term memory for unilateral and bilateral ECT.

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scores increases, unilateral subjects performing considerably better than bilateral subjects. This relationship is shown in Figure 1.

Auditory short-term memory. The main effect of retention interval and the triple interaction of treatment group, retention interval and time of treatment were significant ($F_{3,93} = 63{\cdot}96$; $p < {\cdot}001$ and $F_{3,93} = 3{\cdot}52$; $p < {\cdot}05$). The effect of retention interval is clear: scores decrease consistently with increases in the interval between stimulus presentation and recall.

Most relevant to the present study is the increased decrement for bilateral treated patients and the relation to retention interval. Bilateral treated subjects showed a greater performance decrement when recall was delayed even 6 seconds, and this decrement increased with increasing delays in recall (Fig. 2).

Paired-associate learning test. Unilateral subjects obtained higher recall scores than bilateral subjects ($F_{1,39} = 14{\cdot}94$; $p < {\cdot}001$): immediate recall was greater than delayed recall ($F_{1,39} = 145{\cdot}76$; $p < {\cdot}001$) and pre-treatment performance was better than post-treatment performance ($F_{1,39} = 46{\cdot}07$; $p < {\cdot}001$). However, the most interesting effect is the interaction between treatment group and time of test ($F_{1,39} = 15{\cdot}06$; $p < {\cdot}001$), bilateral treated subjects performing worse than unilateral subjects after treatment (Fig. 3).

Discussion

The data suggest, as expected, differences in memory as a function of ECT electrode placement. In this study, the memory changes seem to be dependent more on interferences with cerebral lateralized functions than with specific parameters of the treatment method or the passage of electricity.

Contradictions in the literature on memory change after ECT are mostly attributable to inadequate control and the selection of memory tasks. It is not certain whether the relevant variables are the modality of input

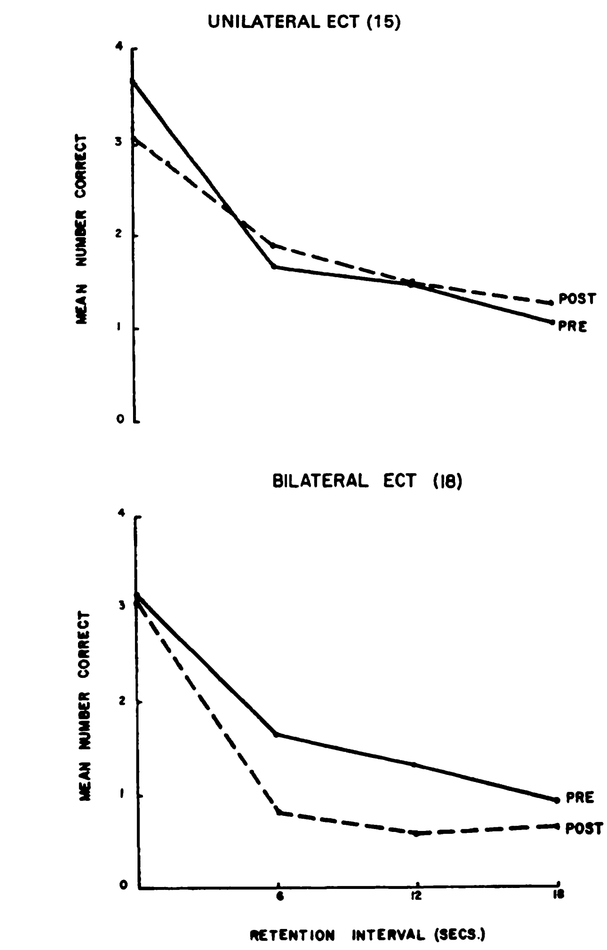

Fig. 2.

Auditory short-term memory with unilateral and bilateral ECT.

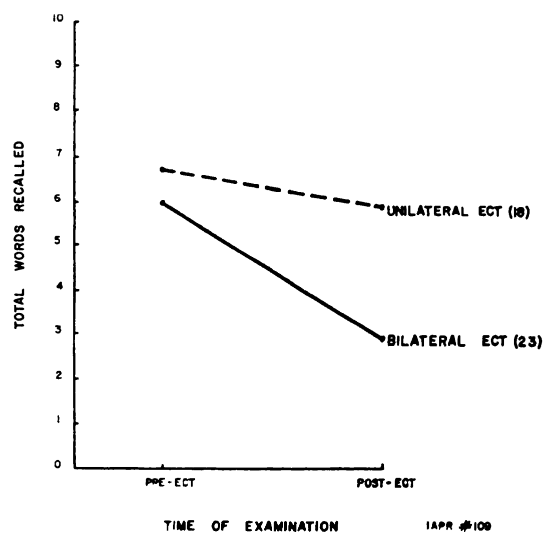

Fig. 3.

Paired associate learning.

or the 'verbalness' of the task, but that either or both of these variables are highly relevant has been adequately demonstrated (Cohen *et al.*, 1969; Kimura, 1963; Milner, 1962). The tasks in the present experiment do not oppose modality and verbalness but rather combine both in a single task.

Recognizing these distinctions, however, the data from the present experiment are clear. On the two verbal auditory tasks the bilaterally treated subjects showed deficits; subjects with unilateral right-sided treatment did not show this same deficit. On the other hand, the visual non-verbal task did not affect bilateral and unilateral performance in the expected manner. Both groups should indeed have been adversely affected on this task; however, recall in the two groups was similar but not significantly worse than pre-treatment levels.

To explain visual data, it is most likely that the interpolated material was too easy and involved very limited use of the available processing capacity (Posner and Konick, 1966). It has been suggested that two separate processing mechanisms or strategies are involved when one is dealing with different modalities and/or two different types of tasks. In the present experiment the visual task involved a high degree of visual imagery and minimal verbalization. The visual imagery (rehearsal) could have proceeded undisturbed by the processing required by the verbal interpolated material. Because of the nature of the relevant task, it was possible for the two tasks, visual non-verbal and interpolated auditory verbal, to be processed simultaneously because each task used different mechanisms. On the other hand, in the auditory verbal task, particularly the short-term memory task, both the relevant stimuli and irrelevant interpolated material involved the same processing system, a system which became overloaded with an abundance of stimuli.

Further, the data suggest that ECT affects the storage of information rather than registration or retrieval; on the auditory short-term memory task, both treatment groups performed similarly at 0 seconds indicating that the stimuli were perceived and retrieved with equal success.

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