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Electroconvulsive Treatment and Short Term Memory

By M. J. STONES

Introduction

Much of the recent work on electroconvulsive shock has been concerned with retrograde amnesia. These studies have generally produced results consistent with Ribot's Law (1885), which states that the susceptibility of a memory to impairment in retrograde amnesia bears an inverse relationship to the age of the trace (Chorover and Schiller, 1965; Kesner and D'Andrae, 1971).

With respect to anterograde amnesia, a body of evidence is building up which suggests that when bilateral ECT is employed as the amnesic agent there is a positive relationship between the length of the retention interval and the severity of the memory defect. The studies reporting such a finding (Cronholm and Molander, 1957; Ottosson, 1960; Zinkin and Birtchnell, 1968; D'Elia, 1971) have usually been concerned with long term memory (LTM), i.e. the retention intervals have been hours or minutes rather than seconds. A recent study by Dornbush, Abrams and Fink (1971) has reported similar results with retention intervals of up to 18 secs. An auditory and a visual short term memory (STM) task were used, but the positive relationship between the extent of the memory impairment and the length of the retention interval was statistically demonstrated only for the auditory task. However, on careful inspection of the graphs provided by Dornbush *et al.*, it becomes apparent that had the shortest of the retention intervals, i.e. immediate recall, been omitted, this positive relationship would certainly have been eliminated. The present study attempted to investigate the proactive effects of ECT on STM, particularly with respect to the length of the retention intervals. In contrast to Dornbush *et al.*, who compared the differential effects of unilateral and bilateral ECT on STM and did not include a no-treatment control group, the present study compares STM in a bilateral ECT group with STM in a no-treatment control group.

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Method

Subjects

The 40 subjects were obtained from the admission wards of a general psychiatric hospital. Half comprised the experimental group and half the control group. The distribution of sexes was even within each group. Ages ranged from 25 to 43 years in the experimental group (mean 31 years) and from 19 to 49 years in the control group (mean 34 years).

Subjects in both the experimental and control groups were of mixed psychiatric diagnosis. No attempt was made to control for psychiatric diagnosis, since the degree of memory disturbance after ECT appears to be largely independent of this variable (Williams, 1966).

Subjects in the experimental group, in contrast to those in the control group, were undergoing a course of bilateral ECT at the time of the experiment. No subject in the experimental group had received an ECT during the month preceding his (or her) current series, and no subject in the control group had received an ECT during the month preceding the experimental period.

ECT administration

Bilateral ECT was administered twice weekly in the conventional manner. Premedication consisted of atropine, about ¾ hr. before treatment, and the anaesthetic was methohexitone, in conjunction with the muscle relaxant, scoline. Oxygen was infused both before and after shock. The current was delivered by an Ectron Ectonus Mk. 3 machine, which incorporates a counter-shock device. Counter-shock does not appear to enhance or diminish the extent of memory loss after ECT (Cronholm and Ottoson, 1961).

STM task

The STM task consisted of 12 items presented successively (by means of a Ferrograph tape

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recorder) at the rate of one item per min. Each item contained six different consonants arranged into three pairs. Each pair was preceded by a sequence of four digits. The temporal sequencing within an item is illustrated in Table I. The digits were played at the rate of one per 1½ secs. and the consonants at the rate of one per sec.

TABLE I
Temporal sequencing of components within an item

Component	Time (secs)
Alterting instruction ..	0–1
Digits	4–10
Consonant pair 1	11–12
Digits	14–20
Consonant pair 2	21–22
Digits	24–30
Consonant pair 3	31–32
Recall instruction	34–36

The subject was required to repeat aloud and individually each digit as it was played to him, but to repeat each consonant pair as a pair. Two seconds after the final consonant pair was presented the instruction 'recall' was read out, followed by a consonant which was the first member of one of the three pairs contained in that item. The subject was required to provide the second consonant in the pair.

The digits, the consonants comprising each pair and the position of that pair in the sequence were derived from a table of random numbers (Edwards, 1964). The only constraints applied to the randomization procedure were that no alphabetically adjacent consonants comprised a pair, and no pair appeared twice in either of the two versions (A and B) of the task.

The retention intervals (for the consonant pairs) were 4, 14 and 24 seconds. The subjects had no prior knowledge of the interval from which recall would be demanded for any specific item. For a given version of the task, recall was demanded from each interval four times.

Procedure

The experimental procedure is outlined in Table II. Each subject was presented successively with both versions of the learning task. The design was balanced so that half the subjects in the experimental group and half the subjects in the control group received task version A first, whilst the others received task version B first. The interval between successive presentations was approximately 24 hours. For the control group, the period before first task presentation and the interval between successive task presentations was filled with their customary ward activities. For the experimental group, however, first task presentation came at least one day after the second ECT of their current series, and the second task presentation was approximately three hours after the third ECT.

TABLE II
Experimental design

Group		First presentation	Experimental manipulation	Second presentation
Experimental	I	Task A	ECT	Task B
	II	Task B		Task A
Control	I	Task A	No ECT	Task B
	II	Task B		Task A

RESULTS

The number of items correctly recalled on the first task presentation was 7·6 for the experimental group and 7·4 for the control group. These values do not differ significantly ($t = 0{\cdot}51$, d.f. = 38).

The main analyses of the study were concerned with changes in STM that took place from first to second task presentation in the experimental group and the control group. To this end 'difference' scores were derived which reflect the deterioration or improvement in STM performance on second task presentation, when compared to the level of STM performance on first task presentation. The difference scores were calculated by subtracting the number of items correctly recalled at each of the retention intervals on first task presentation from the corresponding scores on second task presentation. Thus three scores were obtained for each subject, one at each retention interval. A positive score reflects a facilitation of STM performance on second task presentation, and a negative score a deterioration.

It may be seen from Fig. 1 that whilst the experimental group deteriorated in STM performance from first to second task presentation, the control group actually improved. There was

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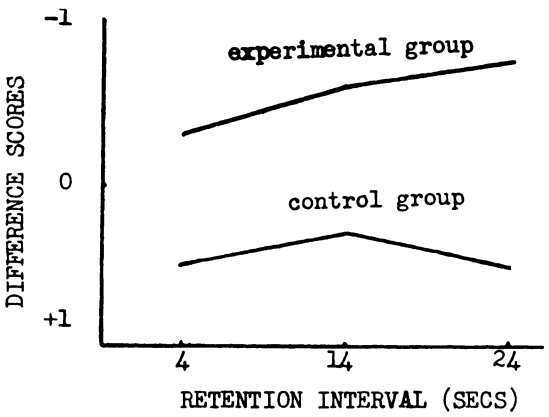


FIG. 1.—Difference scores obtained by the experimental group and the control group.

a slight tendency for the discrepancy between groups to increase as the length of the retention interval increased. However the analysis of variance in Table III shows that although the experimental group and the control group differed significantly, neither the intervals effect nor the interaction term achieved statistical significance.

The retention intervals themselves were associated with differences in level of recall. A mean of 3·6 items were recalled (per version of the task) at the 4 second retention interval, as compared with 2·2 items at the 14 second interval and 1·6 items at the 24 second interval. The differences in level of recall between the 4 second and 14 second intervals ($t = 8·42$, d.f. = 39, $p < ·01$) and between the 14 second and 24 second intervals ($t = 2·70$, d.f. = 39, $p < ·05$) are both significant.

TABLE III
Analysis of variance of difference scores

Source	S. of S.	D.F.	M.S.	F	
Experimental/ control ..	29·00	1	29·00	20·07	p<·01
Error term..	54·92	38	1·45		
Retention intervals..	1·52	2	0·76	0·44	n.s.
Interaction	1·12	2	0·56	0·32	n.s.
Error term..	132·03	76	1·74		

DISCUSSION

The present results confirm the finding of Dornbush *et al.* that STM for verbally presented material is defective after administration of bilateral ECT. Whilst there was no impairment due to the effects of the first two treatments in the series, a disorder was present three hours after the third ECT. The failure to find any impairment caused by the effects of the early treatments was probably due to the long ECT task presentation interval (at least 24 hours), although it cannot be ruled out that the cumulative effects of all three treatments may have been responsible for the STM decrement after the third ECT (Miller, 1970).

Over both groups, the number of items recalled bore an inverse relationship to the length of the retentional interval. However, there was no evidence to suggest that the extent of the STM defect in the experimental group was significantly related to the length of the retention interval. Dornbush *et al.* were able to demonstrate a positive relationship between the magnitude of the STM. impairment and the length of the retention interval with an auditory STM task, but, as has already been mentioned, this was largely due to their inclusion of immediate recall as a retention interval.

A close inspection of the graphs they provide reveals little difference between the unilateral ECT group and the bilateral ECT group (and little difference between the pre-ECT and post-ECT conditions for the bilateral ECT group) with respect to immediate recall, although there were marked differences at the three longer retention intervals. Over the three longer intervals, there is no evidence of a positive relationship between the post-bilateral ECT deficit of STM and the length of the retention interval. The relevant curves run almost parallel and, if anything there is a marginal tendency towards a negative relationship.

It is possible that immediate recall involves retrieval solely from primary memory (Waugh and Norman, 1965), a store with a capacity of 2·5–3·5 linguistic units (Craik, 1971); whilst recall even after a short delay involves a large component of secondary memory, given that the retention interval is filled with irrelevant verbal activity. The results of the present study and those of Dornbush *et al.* appear consistent in showing that when retrieval is not exclusively from primary memory, there is no relationship between the extent of the post-bilateral ECT

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disorder of memory and the length of the retention interval.

This conclusion may be contrasted to that derived from studies investigating the effect of bilateral ECT on LTM. As mentioned in the introductory section, such studies usually report a positive relationship between the severity of the memory disorder and the length of the retention interval. This is usually explained in terms of impaired retention (or storage). However, in LTM studies subject activity during the retention interval is rarely controlled, and it is possible that a differential tendency to engage in rehearsal between subjects in no-ECT and post-ECT condition might account for the results reported.

The present experiment provides no evidence for a post-ECT storage defect in STM. The results are probably best explained as a defect on encoding or retrieval. Unfortunately the data do not permit a differentiation between the alternative hypotheses.

Summary

Two versions of an auditory STM task were presented to 40 subjects who were evenly divided between the experimental and control groups. The design was balanced for version order, and the interval between successive task presentations was 24 hours. The experimental group was presented with the two versions of the task at least one day after the second ECT of their series and approximately three hours after the third ECT. The control group experienced no ECT during the course of the experiment. Each task item contained three consonant pairs and three four-digit sequences. Recall of one consonant pair was demanded per item, the retention interval being either 4, 14 or 24 seconds.

There were no differences between groups in the number of items recalled on first task presentation. The experimental group performed at a lower level on second task presentation. The length of the retention interval was unrelated to the extent of the experimental group impairment, although, over both groups, there was an inverse relationship between level of recall and length of the retention interval.

It is suggested the STM deficit after ECT might reflect a failure of either encoding or of retrieval.

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