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Electroconvulsive Therapy and Complaints of Memory Dysfunction: A Prospective Three-Year Follow-up Study

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SUMMARY: Self-reports of memory problems have been evaluated prospectively in depressed patients receiving bilateral ECT or unilateral ECT, and in depressed patients receiving treatments other than ECT. Depressed patients did not complain of poor memory at seven months after hospitalization. Compared to bilateral ECT, right unilateral ECT was associated with only mild memory complaints. At three years after treatment approximately one-half of the persons who had received bilateral ECT reported poor memory. These reports seemed to be influenced by three factors: (1) recurrence or persistence of conditions that were present before ECT; (2) the experience of amnesia initially associated with ECT and a subsequent tendency to question if memory had ever recovered; and (3) impaired memory for events that had occurred up to six months before treatment and up to about two months afterwards.

Electroconvulsive therapy (ECT) is a safe and effective treatment for depressive illness (Fink, 1979; Turek and Hanlon, 1977). Since memory impairment is its major side-effect (Squire, 1982; Harper and Wiens, 1975), considerable attention has been directed to evaluating its severity and duration. Memory impairment is greater after bilateral ECT than after right unilateral ECT (Squire and Slater, 1978; Reichert *et al*, 1976; Fromholt *et al*, 1973), and cumulates across treatments (Bidder *et al*, 1970; Reichert *et al*, 1976). As measured both by tests of remote memory and by tests of new learning capacity, memory functions gradually improve after treatment is completed. By several months after treatment, the ability to acquire new material is substantially normal (Squire and Chace, 1975). Memory for information acquired prior to treatment also recovers, but persisting memory loss can occur for material acquired near the time of treatment (Squire *et al*, 1981).

Despite this evidence concerning recovery of memory functions after ECT, it has been recognized that this recovery is not always reflected in patients' own reports of their memory abilities. In one study of bilateral ECT, 10 of 16 patients reported at six to nine months after treatment that their memory was not as good as it used to be (Squire and Chace, 1975). In another study of 166 patients who had received either bilateral or unilateral ECT about one year previously, 30 per cent agreed with the statement that their memory had 'never returned to normal after ECT' (Freeman and Kendell, 1980). In an effort to understand these memory complaints, we recently reported the findings of a prospective study of 35 individuals prescribed bilateral ECT who were assessed with a newly developed memory self-rating instrument on three occasions: before ECT, one week after ECT, and five to nine months later (Squire *et al*, 1979). The results several months after ECT reflected a continuing experience of amnesia rather than an experience of depression. It was suggested that a patient's impression of his memory is altered by bilateral ECT and that this impression persists for several months after treatment.

These findings raise additional questions about the impact of ECT:

(1) Is this impression of impaired memory permanent or does it gradually subside?

(2) Does this impression of impaired memory imply perceived difficulty in new learning ability long after ECT or might it apply to a perceived gap in memory around the time of treatment?

(3) What is the impact of these memory complaints on patients' attitudes towards ECT?

To answer these questions we have completed a three-year prospective follow-up study of patients prescribed bilateral ECT. For purposes of comparison, prospective follow-up data up to seven months after hospitalization have also been collected for patients

prescribed right unilateral ECT and for patients hospitalized for depression who did not receive ECT.

Subjects

Bilateral ECT (Table I)

This group was originally composed of 35 in-patients at five local hospitals who had been prescribed a course of bilateral ECT and who had been followed prospectively up to several months after their course of treatment (Squire *et al*, 1979). Of these 35 patients, 5 were lost to our three-year follow-up. Two could not be located, 1 declined to be interviewed and 2 were excluded because they had received an additional course of ECT during the follow-up interval. One additional patient, who had been excluded from the original study because a test one week after ECT could not be given, was now included—making a total of 31 in the follow-up group. The diagnoses recorded on admission by the patients' various psychiatrists were primary affective disorder or severe depression (17); manic depressive illness, depressed phase (9); depressive neurosis (4); and schizoaffective disorder (1). For the three-year follow-up all individuals were first contacted by letter, then by telephone to arrange an appointment, and were subsequently visited in their homes. All interviewing was conducted by the same person.

Right unilateral ECT

This group consisted of 28 in-patients at six local hospitals who had been prescribed a course of right unilateral ECT. The diagnoses as recorded on admission were primary affective disorder or severe depression (19); manic-depressive illness, depressed phase (5); depressive neurosis (2); schizoaffective disorder (1); and unspecified personality disorder (1).

Depressed patients

This group consisted of 19 psychiatric in-patients at one of the participating hospitals who had been admitted for treatment of depressive illness. The specific diagnoses recorded on admission were primary affective disorder or severe depression (14); manic depressive illness, depressed phase (2); neurotic depression (2); and schizoaffective disorder (1).

Electroconvulsive therapy

Treatment was administered three times a week on alternate days following medication with atropine, methohexital sodium and succinylcholine. Decisions concerning the number of treatments were made by the patients' psychiatrists. In all cases, patients were described as having a modified grand mal seizure. For bilateral ECT, electrode placement was bi-temporal. Twenty-seven of the 31 patients in this group received their treatments with a Medcraft machine (sine wave, 130–170 V for 0.6–1 sec). The remaining four patients received their treatments with a Reiter-Cedak Model SOS, a machine which delivers a series of unidirectional brief pulses. For right unilateral ECT, electrode placement followed the method described by D'Elia (1974) (n = 19) or McAndrew *et al* (1967) (n = 9). All patients received their treatment with a Medcraft machine (140–170 V for 0.6–1 sec). The effects of right unilateral ECT on memory have been reported to be similiar despite wide variation in electrode placement (D'Elia, 1976; D'Elia and Widepalm, 1974).

Test and procedures

Test 1: Memory self-rating scale

All 18 test items have been presented previously (Squire *et al*, 1979). Subjects respond to 18 items that ask them to rate various aspects of memory functions e.g. 'now compared to before I began to feel bad and went to the hospital'. Ratings are made on a nine-point scale from −4 (worse than ever before) through 0 to +4 (better than ever before). For patients prescribed bilateral ECT, this scale had previously been administered one to two days prior to treatment, one week after the course of treatment and again seven months later (range 5–9 months, mean = 6.8 months). In the present study, 31 of the original 35 patients were tested about three years after ECT (range 25–41 months, mean = 34.7 months). For 28 patients prescribed right unilateral ECT, this scale was administered one to two days prior to treatment, one week after the course of treatment and again about seven months later (range 5–13 months, mean = 6.5 months). For 19 depressed patients not receiving ECT, the scale was administered during initial hospitalization and again about seven months later (range 6–10 months, mean = 7.4 months).

Test 2: Time line

This method of illustrating the temporal aspects of memory loss has been adapted from Barbizet (1970, p. 126). Subjects are shown a horizontal line 10½ in. long and told that the line is intended to represent time. The line is labelled at several points from right to left: now, two years after ECT, one year after ECT, time of ECT (with the month and year written in for each subject), one year before ECT, two years before ECT, five years before ECT, ten years before ECT and more than ten years before ECT.

Subjects are asked to indicate on the line any periods of time that they have difficulty remembering, either prior to or after ECT. To obtain a similiar estimate

before ECT, subjects were asked simply to state what time periods, if any, they had difficulty remembering. For 31 patients prescribed bilateral ECT, time estimates were obtained before treatment, seven months after treatment and at the three-year follow-up.

Test 3: Structured interview

A structured interview was constructed that asked 13 questions about the ECT experience (see Table 1). This interview was administered to the group prescribed bilateral ECT on the occasion of the three-year follow-up.

Results

Fig 1 shows the results with the self-rating scale from the time of hospitalization to seven months later. Following methods developed in previous work with this scale (Squire *et al*, 1979), we have presented the data obtained from each testing occasion as best-fitting lines constructed across the scores for the 18 items. To construct these lines, scores for each of the 18 items on the self-rating scale were first averaged across subjects. Then the means were ordered, as described previously, according to the magnitude of the difference between the scores obtained before and one week after bilateral ECT. Thus item 1 to the extreme left of each panel yielded the largest difference, and item 18 to the extreme right yielded the smallest difference. After the mean scores for the 18 items were ordered, regression lines were calculated across these scores according to the method of least squares.

The data from the three groups can be summarized as follows. First, there were no differences in the

TABLE 1

*Subject characteristics for electroconvulsive therapy (ECT) groups and control**

	Bilateral ECT (n = 31)	Right unilateral ECT (n = 28)	Depressed patients (n = 19)
Mean age at follow-up	45 (28–68)	40 (17–68)	45 (23–62)
Sex	25 F	22 F	13 F
Years of education	12.5	12.6	12.5
Number of treatments	10.9 (5–21)	9.2 (5–18)	
Number of patients with no ECT history prior to study**	19	18	19

* Values are expressed as means, ranges are in parentheses.

** None of the patients had received ECT during the preceding year. Twelve bilaterally treated (BL) patients and nine right unilaterally treated (RUL) patients had received one prior course of treatment, on average 6.7 years (BL patients) and 10.7 years (RUL patients) previously. One RUL patient had received two courses, four years ago and nine years ago.

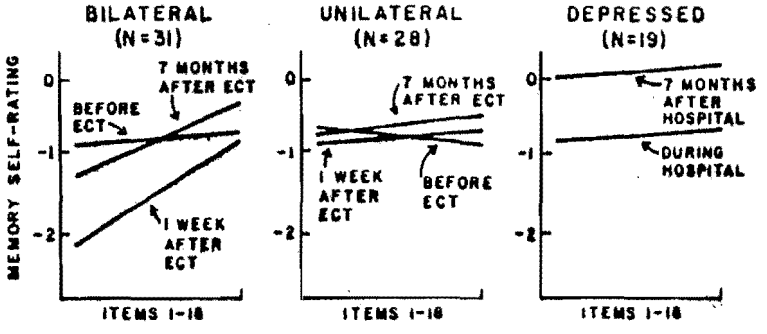

FIG 1.—Self-ratings of memory (on a −4 to +4 scale) by patients prescribed bilateral ECT or right unilateral ECT, and by a control group of depressed patients not receiving ECT. The self-rating scale was administered on two or three occasions as shown. The order of items appearing on the test was random. Here the group means obtained for each of the 18 items have been ordered according to the difference in the means obtained before and one week after bilateral ECT. Items to the left of each panel yielded the largest difference, and items to the right yielded the smallest difference. Data are here represented as best-fitting lines across the group means for all test items.

degree of memory complaints before ECT, either in terms of overall mean score ($F < 1.0$ [2, 75], $P > 0.1$) or in terms of the slopes of the regression lines ($F = 1.6$ [2, 75], $P > 0.1$). The average scores were −0.78 (bilateral ECT), −0.78 (unilateral ECT), and −0.77 (depressed group). These scores were all well below the zero level (ts >10, $P < 0.01$), confirming previous findings that depression is associated with quantifiable self-reports of poor memory.

Secondly, bilateral ECT, but not right unilateral ECT, produced initially a level of memory complaint well beyond that produced by depression alone. For bilateral ECT, the mean self-rating score changed from −0.78 before treatment to −1.47 one week after treatment ($F = 4.7$ [1, 29], $P < 0.04$). For unilateral ECT, the corresponding change was from −0.78 to −0.73 ($F = 0.4$ [1, 27], $P > 0.1$). Thus at one week after treatment, bilateral ECT was associated with a greater degree of self-reported memory impairment than unilateral ECT ($F = 5.7$ [1, 56], $P < 0.05$).

Thirdly, one of the effects of ECT was to change the pattern of self-ratings so that some items were rated worse than others. Thus for both bilateral and right unilateral ECT, the slope of the regression line was significantly different one week after ECT from that before ECT (for bilateral ECT, $F = 10.4$ [1, 29], $P < 0.01$; for unilateral ECT, $F = 9.7$ [1, 27], $P < 0.01$). Since patients are demonstrably amnesic one week after a course of bilateral ECT as measured by formal tests (Squire *et al*, 1976; Cronholm and Bloomquist, 1959), the slope of the regression line observed at this time has been taken to reflect an amnesic pattern of performance. In this regard, it is significant that the slope of the regression line one week after bilateral ECT was greater than one week after unilateral ECT ($F = 9$ [1, 56], $P < 0.01$).

Fourthly, in marked contrast to the similarity between groups before ECT, the three groups differed from each other seven months later with respect to the severity of memory complaints ($F = 3.5$ [2, 75], $P < 0.05$). The average score at this time was −0.83 (bilateral ECT), −0.55 (unilateral ECT) and +0.12 (depressed group). The depressed group exhibited a significant improvement over their previous score ($F = 23.9$ [1, 18], $P < 0.01$). The bilateral ECT group were also improved over their score one week after ECT ($F = 7.5$ [1, 29], $P < 0.01$). Whereas the average scores for each ECT group were now similar to the before-ECT scores, they remained below the zero level (ts >7, $P < 0.01$).

Finally, the pattern of memory complaints reported seven months after ECT was different from that before ECT. The data reported here provide additional evidence that patients' estimates of their own memory abilities at seven months after treatment have been affected to some degree by ECT. This conclusion follows from the finding that the slopes of the regression lines for the two ECT groups differed from their slopes before treatment (bilateral ECT: $F = 6.45$ [1, 30], $P < 0.02$; unilateral ECT: $F = 11.97$ [1, 27], $P < 0.01$). Both slopes were in fact indistinguishable from the slopes at one week after treatment ($Fs < 1$, $P > 0.1$).

Fig 2 shows the results for patients prescribed bilateral ECT, who were administered the self-rating scale an additional time three years after their course of treatment. Patients who received bilateral ECT seem to have experienced some persisting change in the perception of their memory abilities. This point follows from the finding that the scores at seven months and three years were similar ($F < 1$ [1, 30], $P > 0.1$), and that the slopes of the two regression lines were also similar ($F = 1.3$ [1, 30], $P > 0.1$). Moreover, the overall memory self-rating score at three years remained below the zero level ($t = 10.6$, $P < 0.01$) and significantly lower than the score of the depressed group at seven months after hospitalizaton ($F = 8.9$ [1, 48], $P < 0.01$).

Fig 3 shows how the 31 patients prescribed bilateral ECT described the time periods that they had difficulty remembering. The bars depict the median response of the group just prior to ECT (top), seven months after ECT (middle) and three years after ECT (bottom). The median time period affected was calculated separately for the months leading up to ECT and for the months after ECT. Prior to ECT, patients expressed difficulty remembering a median of five months into the past. Seven months after ECT, the median response was two years before ECT and three months after ECT. Three years after ECT, the median response was six months before ECT and two months after ECT.

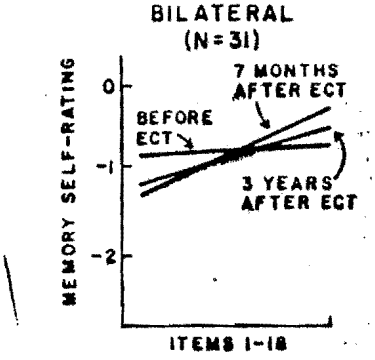

FIG 2.—Self-ratings of memory before, seven months after and three years after bilateral ECT. Scores are here represented as best-fitting lines across the scores for all test items.

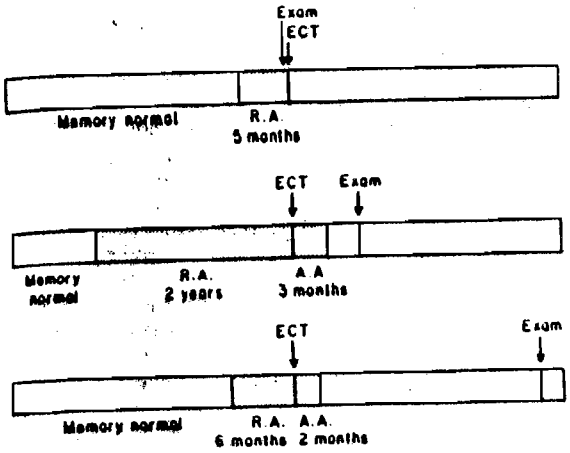

FIG 3.—Estimates of time periods that are difficult to remember obtained before (top bar), seven months after (middle bar) and three years after (bottom bar) bilateral ECT (N = 31). Shaded areas represent the median time period perceived as affected both from the period before ECT (i.e., RA retrograde amnesia) and after ECT (i.e., AA anterograde amnesia). Since the first time estimate was obtained just prior to ECT (top bar), the five months perceived as affected at that time presumably reflects memory problems associated with depressive illness.

The results obtained with these time lines make three general points about the experience of memory problems after bilateral ECT. First, the six-month retrograde amnesia (RA) reported at three years after treatment was significantly less than the two-year RA reported at seven months after treatment ($T = 17.1$, $P < 0.01$, Wilcoxcon matched pairs, signed ranks test), and not measurably different from the five months perceived as affected before ECT was given ($T = 276$, $P > 0.1$). Shrinking RA has been reported routinely in the clinical neurological literature, particularly in the case of head trauma (Barbizet, 1970; Russell and Nathan, 1946; Benson and Geshwind, 1967), and has been demonstrated in the case of ECT using formal tests (Squire *et al*, 1981).

Secondly, the anterograde amnesia (AA: loss of new learning capacity) associated with ECT was stable from seven months after ECT to three years afterwards. This finding corresponds to what should be expected for patients who gradually recover from a period of AA. Though the capacity for new learning returns, memory for the period during which this capacity was affected does not return, presumably because memories were not being established in the normal way during the affected period.

Thirdly, the typical individual prescribed bilateral ECT did not express difficulty at follow-up in remembering day-to-day events or events from the recent past. Indeed, only 1 of 31 persons reported this experience. In addition, 4 other persons reported an intermediate experience in which memories up to the present time were described as 'hazy', but not 'blank' or 'impossible to remember'.

Table II shows the results of the structured interview. The data show that roughly half of the 31 individuals interviewed had a positive attitude about ECT. For example, 45 per cent (14) had no complaint about ECT as far as their memory was concerned. Fifty-five per cent (17) felt that their memories were not as good as those of other people of the same age and that this was related to their having received ECT. These two groups were of similar age (47 *vs.* 43) and had received similar numbers of treatments (10.5 *vs.* 11.3). In an effort to describe the characteristics of those persons who reported memory problems at three years after ECT, responses in the structured interview were examined separately for the 17 who reported memory problems and for the 14 who did not. There was a significant association between reports of memory problems and the report that ECT either did not help at all or helped for no longer than three months ($\chi^2 = 9.2$, $P < 0.01$). There was also a significant association between reports of memory problems and the response that ECT would not be requested if the same condition occurred again ($\chi^2 = 9.2$, $P < 0.01$).

We next examined the time line data (Fig 3) to determine if those individuals reporting memory problems at three years after ECT also reported a longer period of time that was difficult to remember than individuals not reporting memory problems. Using the data from Fig 3, no difference was found in the affected time periods (for the 17 with reported memory problems, median RA = 6 months, median AA = 2 months; for the 14 without reported memory problems, median RA = 8.4 months, median AA = 2.5 months).

We next compared scores on the memory self-rating scale (test 1) obtained three years after ECT by the 17 individuals with reports of memory problems at that time and the 14 individuals with no complaints. As might have been expected, these comparisons revealed significantly lower scores for the subjects who reported memory problems (mean = −1.62) than for those who did not (mean = −0.02) ($F = 15.6$ [1, 29], $P < 0.01$. The slopes of the two sets of scores across the 18 test items were similar ($F = 2.36$ [1, 29], $P > 0.1$).

Finally, we sought to compare these two groups on some objective measure of memory performance. Most of the subjects had previously participated in follow-up studies of remote memory functions conducted about six months after treatment, and had taken one or more of the following three tests: remote

TABLE II

Responses to structured interview three years after bilateral electroconvulsive therapy (ECT) (N = 31)

1. Did the treatment cause pain?	
None	67.7%
Slight or moderate	22.6%
Excruciating	6.5%
No memory	3.2%
0–4 scale: mean score =	0.5
2. What was the reason you received ECT?	
Depression	87.1%
Other	9.7%
No memory	3.2%
3. How much did ECT help?	
Did not help	38.7%
Helped a little	29%
Helped a lot	32.3%
0–9 scale: mean score =	4.5
4. How long did helpful effect last?	
To present time	42%
12 months	3.2%
1–3 months	16.1%
Not applicable	38.7%
5. How did experience of ECT compare with expectations?	
As expected	35.5%
Memory problems worse	9.7%
More scary or stressful	3.2%
Less scary or stressful	25.8%
More effective	3.2%
Less effective	22.6%
6. Would you ask for ECT again?	
Yes	45%
No	55%
7. Would you agree to ECT with your doctor's recommendation?	
Yes	51.6%
No	41.9%
Maybe	6.5%
8. Would you recommend ECT to relatives or children?	
Yes	45%
No	55%
9. Given choice, would you choose ECT or antidepressant drugs for 3–6 months?	
ECT	48.3%
Drugs	45.2%
Neither	6.5%
10. Has ECT caused you embarrassment?	
No	58.1%
Yes, because of memory problems	19.3%
Yes, other reasons	22.6%
11. Did you have memory problems during first week outside hospital?	
Yes	87%
No	13%
12. Do you think your memory is as good as for most people your age?	
Yes	42%
No	58%
13. Do you feel ECT had anything to do with how your memory is now?	
Yes	54.8%
No	3.2%
Not applicable	42%

memory for current events (Squire *et al*, 1981); detailed recall of former one-season television programmes (Squire *et al*, 1981); and memory for temporal order of former television programmes (Squire *et al*, 1976). Data from these tests were available for 13 of the 17 persons who reported memory problems (mean = 1.7 tests per subject) and 12 of the 14 persons who did not (mean = 1.3 tests per subject). To compare performance across tests, all scores for each test were converted to z scores. The two groups performed similarly on these tests (13 of those with reported memory problems, $z = -0.05$; 12 of those without reported memory problems, $z = +0.03$; $t = 1.0$ [24], $P > 0.1$).

Taken together, these data indicate that 55 per cent (17) of our sample responded negatively to the direct question, 'Is your memory as good as for other persons your age?' and attributed their memory problem to ECT. Compared to persons not reporting memory problems, these persons also reported significantly more memory problems on the self-rating scale. In an interview, these persons stated that ECT was significantly less helpful than did persons who did not report memory problems, and they indicated significantly less often that they would request ECT again if the same condition recurred. Finally, with respect to remote performance assessed about six months after treatment, they did not differ from persons without memory complaints.

Discussion

Whereas the depressed group reported no memory problems at all at follow-up, both ECT groups reported a negative average self-rating that was no better than the self-rating score before ECT (Fig 1). This result could be interpreted as evidence for a persisting effect of ECT on memory self-reports, but this conclusion cannot be a strong one. There may have been pre-existing differences in the characteristics of the patients in the three treatment groups that influenced their memory self-ratings seven months after treatment. For example, patients prescribed ECT might initially have been more depressed than patients not prescribed ECT. This point could be settled conclusively by a study in which patients were randomly assigned to treatment groups.

About half the patients prescribed bilateral ECT subsequently felt that their memory had never returned to normal; and even when all the patients prescribed bilateral ECT were considered as a group, ECT changed the quality or pattern of memory complaints in a lasting way. We believe these persisting reports of memory problems reflect the influence of three different factors.

In the first place, if there was recurrence or persistence of some of the conditions present before ECT, then these conditions could contribute to a general depression of self-rating scores across all test items. That there might be a place for this factor in understanding memory complaints is supported by the association between memory complaints and the feeling that ECT did not help.

Secondly, the pattern of memory complaints reported up to three years after bilateral ECT resembled the pattern of complaints reported at one week after treatment when patients were amnesic, and it differed from the pattern of complaints reported before ECT when patients were depressed. If only those 17 patients who had memory complaints are considered, then the pattern of these complaints at three years after treatment was clearly of the 'amnesic type'. One way of understanding how such complaints could occur long after ECT is to suppose that they are based on the experience of amnesia initially associated with ECT and reflect a persisting, and perhaps altogether natural, tendency to question whether memory functions have fully recovered.

Thirdly, the findings with the time line at three years after treatment (RA = six months, AA = two months) suggest that reports of memory problems may be veridical, in that they can refer to a gap of several months around the time of treatment. A similar interpretation of memory complaints has been suggested by Freeman and Kendell (1980). The estimate of AA obtained here matches rather well estimates of the duration of AA obtained with formal tests (cf. Squire, 1982; Freeman and Kendell, 1980 and references therein).The estimate of six months' RA, however, may have been influenced to some degree by the earlier effects of depression, since nearly the same estimate (five months) was obtained even before treatment. Importantly, the data from the time lines (Fig 3) suggest that memory complaints long after bilateral ECT are usually not complaints about new learning capacity or complaints about memory for the recent past.

We cannot determine whether these three factors are the only ones that deserve consideration or, if so, how they should be weighted. It does seem worth emphasizing, however, that the available data provide no basis for supposing that ECT is associated with a permanent loss of memory functions, beyond what is represented by the time line data: i.e. an RA of about six months and an AA of two months. At the same time, even this degree of amnesia is substantial and is of concern to many patients. Right unilateral ECT is considered to be as therapeutically effective as bilateral ECT (D'Elia and Raotma, 1975; Strömgren, 1973; but see discussion by Abrams,1982); yet unilateral ECT is associated with markedly less memory impairment (Squire and Slater, 1978; Reichert *et al*, 1976; Fromholt *et al*, 1973). The present study indicates that the effects of right unilateral ECT on memory are also of less concern to persons who receive the treatment. This information should be useful in counselling patients about the risks and benefits of ECT and in reaching informed choices about possible alternative treatments.

Acknowledgments

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References

Abrams R. (1982) Technique of electroconvulsive therapy. In *Electroconvulsive Therapy* (eds. R. Abrams and W. B. Essman). Jamaica, New York: Spectrum Publications.

Barbizet, J. (1970) *Human Memory and its Pathology*. San Francisco: W. H. Freeman.

Benson, D. F. & Geschwind, N. (1967) Shrinking retrograde amnesia. *Journal of Neurology, Neurosurgery, and Psychiatry*, **30**, 539–44.

Bidder, T. G., Strain, J. J. & Brunschwig, L. (1970) Bilateral and unilateral ECT: Follow-up study and critique. *American Journal of Psychiatry*, **127**, 737–45.

Cronholm, B. & Bloomquist, C. (1959) Memory disturbances after electroconvulsive therapy. 2. Conditions one-week after a series of treatments. *Acta Psychiatrica Scandinavica*, **34**, 18.

D' Elia, G. (1976) Memory changes after unilateral electroconvulsive therapy with different electrode positions. *Cortex*, **12**, 280–9.

—— (1974) Unilateral electroconvulsive therapy. In *Psychobiology of Convulsive Therapy* (eds. M. Fink, S. Kety, J. McGaugh *et al*). Washington, DC: V. H. Winston.

—— & Raotma, H. (1975) Is unilateral ECT less effective than bilateral ECT? *British Journal of Psychiatry*, **126**, 83–9.

—— & WIDEPALM, K. (1974) Comparison of frontoparietal and temporoparietal unilateral electroconvulsive therapy. *Acta Psychiatrica Scandinavica*, **50**, 225–32.

FINK, M. (1979) *Convulsive Therapy: Theory and Practice*. New York: Raven Press.

FREEMAN, C. P. L. & KENDELL, R. E. (1980) ECT. I. Patients' experiences and attitudes. *British Journal of Psychiatry*, **137**, 8–16.

FROMHOLT, P., CHRISTENSSEN, A. L. & STRÖMGREN, L. S. (1973) The effects of unilateral and bilateral electroconvulsive therapy on memory. *Acta Psychiatrica Scandinavica*, **49**, 466–78.

HARPER, R. G. & WIENS, A. N. (1975) Electroconvulsive therapy and memory. *Journal of Nervous and Mental Disease*, **161**, 245–54.

MCANDREW, J., BERKEY, B. & MATTHEWS, C. (1967) The effects of dominant and nondominant unilateral ECT as compared to bilateral ECT. *American Journal of Psychiatry*, **124**, 483–90.

REICHERT, H., BENJAMIN, J., NEUFELDT, A. H. & MARJERRISON, G. (1976) Bilateral and nondominant unilateral ECT. II. Development of prograde effects. *Canadian Psychiatric Association Journal*, **21**, 79–86.

RUSSELL, W. R. & NATHAN, P. W. (1946) Traumatic amnesia. *Brain*, **69**, 280–300.

SQUIRE, L. R. (1982) Neuropsychological effects of ECT. In *Electroconvulsive Therapy*, (eds. R. Abrams and W. B. Essman). New York: Spectrum Publications.

—— & CHACE, P. M. (1975) Memory functions six to nine months after electroconvulsive therapy. *Archives of General Psychiatry*, **32**, 1557–64.

—— & SLATER, P. C. (1978) Bilateral and unilateral ECT: effects on verbal and nonverbal memory. *American Journal of Psychiatry*, **11**, 1316–20.

—— CHACE, P. M. & SLATER, P. C. (1976) Retrograde amnesia following electroconvulsive therapy. *Nature*, **260**, 775–7

—— SLATER, P. C. & MILLER, P. L. (1981) Retrograde amnesia following ECT: long-term follow-up studies. *Archives of General Psychiatry*, **38**, 89–95.

—— WETZEL, C. D. & SLATER, P. C. (1979) Memory complaint after electroconvulsive therapy: assessment with a new self-rating instrument. *Biological Psychiatry*, **14**, 791–801.

STRÖMGREN, L. S. (1973) Unilateral versus bilateral electroconvulsive therapy. *Acta Psychiatrica Scandinavica*, Supplement, **240**, 8–65.

TUREK, I. S. & HANLON, T. E. (1977) The effectiveness and safety of electroconvulsive therapy (ECT). *Journal of Nervous and Mental Disease*, **164**, 419–31.

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