ORIGINAL ARTICLE

The Effects of Electroconvulsive Therapy on Memory of Autobiographical and Public Events

Sarah H. Lisanby, MD; Jill H. Maddox, BA; Joan Prudic, MD; D. P. Devanand, MD; Harold A. Sackeim, PhD

Background: Retrograde amnesia is the most persistent cognitive adverse effect of electroconvulsive therapy (ECT); however, it is not known whether ECT has differential effects on autobiographical vs impersonal memories. This study examined the short- and long-term effects of differing forms of ECT on memory of personal and impersonal (public) events.

Methods: Fifty-five patients with major depression were randomly assigned to right unilateral (RUL) or bilateral (BL) ECT, each at either low or high electrical dosage. The Personal and Impersonal Memory Test was administered by blinded raters at baseline, during the week after ECT, and at the 2-month follow-up. Normal controls were tested at matched intervals.

Results: Shortly after ECT, patients recalled fewer events and event details than controls, with the deficits most marked for impersonal compared with personal events. Bilateral ECT caused more marked amnesia for events and details than RUL ECT, and especially for impersonal memories. These effects were independent of electrical dosage and clinical outcome. At the 2-month follow-up, patients had reduced retrograde amnesia, but continued to show deficits in recalling the occurrence of impersonal events and the details of recent impersonal events.

Conclusions: The amnestic effects of ECT are greatest and most persistent for knowledge about the world (impersonal memory) compared with knowledge about the self (personal memory), for recent compared with distinctly remote events, and for less salient events. Bilateral ECT produces more profound amnestic effects than RUL ECT, particularly for memory of impersonal events.

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THE COGNITIVE adverse effects of electroconvulsive therapy (ECT) limit its use. The most persistent adverse effect is retrograde amnesia.[1] Shortly after ECT, most patients have gaps in their memory for events that occurred close in time to the course of ECT, but the amnesia may extend back several months or years.[2-6] Retrograde amnesia usually improves during the first few months after ECT. Nonetheless, for many patients, recovery is incomplete, with permanent amnesia for events that occurred close in time to the treatment.[6,7]

It is not known whether our knowledge of ourselves (autobiographical events) or our knowledge of events in the world (public or impersonal events) is more vulnerable to the amnestic effects of ECT. For several decades, it has long been thought that ECT exerts its most profound adverse effect on autobiographical memory.[1,8-12] Theoretically, such a pattern would support a dissociation in the memory systems subserving the recall of autobiographical and public events.[13-15]

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It seems counterintuitive that ECT exerts a greater effect on autobiographical compared with impersonal information. Autobiographical events should generally be subject to deeper encoding, more extensive elaboration, more frequent retrieval, and have greater affective intonation and personal significance, making them more memorable.[16-20] Nonetheless, there are reports that medial temporal lobe damage results in more extensive retrograde amnesia for autobiographical than public events (see Nadel and Moscovitch[15] for a review), with the amnesia for autobiographical events extending further back in time.[21-24] However, amnesia for autobiographical and impersonal events has rarely been compared in ECT

From the Department of Biological Psychiatry, New York State Psychiatric Institute, New York (Drs Lisanby, Prudic, Devanand, and Sackeim and Ms Maddox); and the Departments of Psychiatry (Drs Lisanby, Prudic, Devanand, and Sackeim) and Radiology (Dr Sackeim), Columbia University College of Physicians and Surgeons, New York, NY.

SUBJECTS AND METHODS

SUBJECTS

Fifty-five patients and 36 normal controls participated after providing informed consent. Patients met the Research Diagnostic Criteria[31] (RDC) for major depressive disorder based on interviews using the Schedule for Affective Disorders and Schizophrenia (SADS) interviews.[32] At the pre-ECT baseline assessment, patients had 24-item Hamilton Rating Scale for Depression[33] (HRSD) scores of at least 18. Exclusion criteria included history of schizophrenia, schizoaffective disorder, other functional psychosis, rapid-cycling bipolar disorder, neurological insult or illness, recent substance abuse, ECT within the past 6 months, or current serious medical illness.

Prior to ECT, patients had received a mean (SD) of 2.2 (1.3) antidepressant medication trials, with diverse medication regimens and augmentation strategies. Using the Antidepressant Treatment History Form criteria,[34-36] 31 (56%) of 55 patients had not responded to at least 1 or more adequate medication trials. Except for lorazepam (up to 3.0 mg/d as needed), patients were withdrawn from psychotropic medications at least 5 days before neuropsychological evaluations and ECT courses. Using an upper limit of 30 days, the depressed sample had been free of all other psychotropics for a mean (SD) of 11.1 (10.2) days before the baseline memory assessment and 17.3 (8.0) days before ECT.

Controls had a negative lifetime history of all RDC disorders based on SADS interviews, and Beck Depression Inventory[37] scores no greater than 9. They met the same exclusion criteria as patients. Controls were free of prescription medication for at least 4 weeks at all assessments. Patients were participants in a trial examining the safety and efficacy of different forms of ECT,[38] and had been referred for ECT by physicians throughout the New York region and, in some cases, nationwide. Controls were recruited from advertisements in local newspapers and were reimbursed for their participation.

ELECTROCONVULSIVE THERAPY

Patients were randomly assigned to treatment conditions, crossing the factors of electrode placement (right unilateral [RUL] vs bilateral [BL]) and stimulus intensity (low vs high electrical dosage).[38] Treatments were administered 3 times per week. Anesthetic medications included atropine (0.4 mg, intravenously), methohexital sodium (0.75 mg/kg), and succinylcholine chloride (0.5 mg/kg). A custom-modified MECTA SR-1 device (Mecta Corp, Lake Oswego, Ore) was used. The standard bifrontotemporal electrode placement was used for BL ECT and the d'Elia placement[39] for RUL ECT. The empirical titration procedure[40] to determine seizure threshold was conducted at the first and last treatments. The low-dosage groups received an electrical intensity just above seizure threshold at all treatments. Except for the first and last treatments, patients assigned to the high-dosage groups received an electrical intensity that was 2.5 times the seizure threshold determined in the first session treatment.

The patients, neuropsychology technicians, and clinical evaluation team were masked to the randomized assignments. The clinical evaluation team, composed of a research psychiatrist (J.P.) and social worker, completed HRSD ratings twice weekly during the ECT course and determined the number of treatments. Electroconvulsive therapy was stopped when patients were asymptomatic or did not show further improvement over at least 2 treatments. At least 10 treatments were required before classifying patients as nonresponders. This criterion was reduced to 8 treatments for patients who showed little or no improvement during the ECT course. Patients classified as responders had a decrease of at least 60% in HRSD scores immediately after ECT compared with baseline, a maximal post-ECT HRSD score of 16, and maintenance of these gains for at least 1 week after ECT while free of psychotropic medication. Nonresponders were eligible for an open crossover phase with high-dosage BL ECT. The ECT and evaluation procedures in this open phase were identical to those in the randomized phase.

ASSESSMENT INTERVALS

All 55 patients were retested with the PIMT during the week after the randomized treatment phase, while free of psychotropic medications. Thirty-three patients completed the PIMT 8 weeks after ECT (randomized or crossover treatment), while receiving continuation pharmacotherapy with heterogeneous regimens. The most common treatment regimen was with a tricyclic antidepressant, either alone (n=16) or in combination with lithium carbonate (n=6). Other regimens included selective serotonin reuptake inhibitors (n=5), lithium (n=8), monoamine oxidase inhibitors (n=3), neuroleptics (n=4), and benzodiazepines (n=7).

Twenty-three of the 36 controls were retested after a mean (SD) of 35.5 (9.3) days, simulating the interval to post-ECT testing of the inpatients (mean [SD], 32.2 [12.7] days; t_{76}=1.1; P=.27). Nineteen controls were tested on a third occasion, simulating the 2-month follow-up testing of patients. Since 12 patients received crossover treatment, the interval between post-ECT and 2-month follow-up testing was longer for patients than controls (patients: mean [SD], 74.2 [20.2] days; controls: mean [SD], 58.5 [8.2] days; t_{50}=3.2; P=.002).

THE PIMT

Task Structure

The PIMT task structure was identical for the personal and impersonal components. Subjects recalled discrete events that occurred within the past 4 years. Five categories of both personal events (gifts given or received, illnesses in family members or friends, major purchases made, trips taken to places at least 50 miles away, and restaurants visited) and impersonal events (births and deaths of famous people, political changes, court cases or trials, natural and man-made disasters, and other major news stories) were used. For each category, subjects recalled as many unique events as possible, up to a maximum of 20 unique events. After recalling events (completing a category), subjects reported the month and year each event occurred. After completion of all 5 categories in the personal or impersonal component, the most recent and most remote (temporally distant) events were identified, based on the subjective time estimates. Subjects then provided as many details as possible about these recent and remote personal and impersonal events. All the recent events were dated as occurring within 3 months of the baseline assessment and all remote events were dated as occurring at least 3 years earlier.

Order of administration of the PIMT components was randomized at each testing session. Order of category presentation within the personal and impersonal components was also randomized, with the constraint that the residual category of "other headlines" was always presented last among the impersonal categories. At all sessions, the dating of events reported at the 2 retesting sessions was coded in terms of the number of months before baseline assessment. The specific events selected at baseline for the recall of details were used again at the retesting occasions. The public events reported at each assessment by a random sample of 14 patients (495 events) and 8 controls (824 events) were reviewed. Only a small fraction (patients: 3%, controls: 5%) could not be verified as pertaining to an actual event. In addition, a small percentage of verified events fell outside the 4-year time frame (patients: 4%, controls: 3%).

MEMORY MEASURES

Event Recall and Memory of Details

Total scores were computed for the number of events recalled by adding across the 5 categories within the personal and impersonal components, respectively. To achieve normal distributions, statistical analyses were performed after square-root transformation. Change in event recall at later assessments (ie, amnesia) was calculated as the percentage change from baseline [100 × (post − pre)/pre]. The total number of discrete details reported was scored for each of the 4 events. After square-root transformation, change in detail recall at subsequent assessments was also calculated as the percentage change from baseline.

Consistency With Baseline and Temporal Dating of Events

Reported events were transcribed verbatim. Each event reported at later assessments was coded as either identical to an event reported at baseline or as a new event. The mean number of months past (ie, how long ago subjects estimated the events to have occurred) was computed at baseline for the personal and impersonal tasks, and at later assessments as a function of whether events were remembered (identical to baseline), forgotten (reported only at baseline), or new. The accuracy of the subjective date estimates was not examined.

Event Salience

For the personal memory component, each event was rated for objective salience, using a 3-point scale. For gifts, purchases, and restaurants, the 3 levels corresponded to the subject's estimate of expense. For example, for major purchases, the 3 levels were as follows: less than $300, $300 to $2000, and more than $2000. Trips were distinguished by distance traveled. For illnesses, the Seriousness of Illness Rating Scale[41] was used. This scale's mean rankings of disease seriousness on this scale were divided into thirds, ranging from least to most serious.

Autobiographical Memory Interview

Fifty-two (95%) of 55 patients also completed the Columbia University Autobiographical Memory Interview (AMI)[11,42] at baseline and after ECT. At 2-month follow-up, 31 (94%) of 33 patients completed the AMI. The AMI is a structured interview, with 281 directed inquiries about personal memories. It elicits information about illnesses, employment history, places of residence, travel, entertainment activities, and both emotionally laden and everyday events in the lives of the patients and their significant others. A descriptive response (name, location, or event description) was required for 185 items. These items were used to derive scores for total event recall and retrograde amnesia. At retest, patients were administered only those items for which they gave a definite answer at baseline. Amnesia was quantified as the ratio of the number of items in which the retesting responses was inconsistent with baseline, relative to the total number of responses produced at baseline. Corroborating patient responses through a family member, it has been shown in this sample that AMI amnesia scores are equivalent when only corroborated items are examined or when all items are included in statistical analyses.[11] The AMI is particularly sensitive to short- and long-term ECT amnestic effects.[7,11,38,42] To test the concurrent validity of the PIMT, associations between PIMT and AMI total recall and amnesia scores were examined. These relations were tested with all 185 AMI descriptive items, with the 28 items that explicitly inquired about personal events in the past year, and with the subset of 185 corroborated items.

DATA ANALYSIS

Demographic features of the patients and control groups were compared using t tests and χ^2 analyses. Repeated-measures analysis of covariance (ANCOVA) was used to compare the groups at baseline in total recall of personal and impersonal events, with event type (personal vs impersonal) as the repeated measure. The covariates were age, education, and socioeconomic status.[43] These covariates were chosen based on analyses showing associations with event recall and/or differences in their distributions among patients and controls. Repeated-measures ANCOVA was also used to compare the groups in memory of details, with event type (personal vs impersonal) and event recency (remote vs recent) as the repeated measures.

Patients and controls were compared for change in event recall using repeated-measures analyses of variance (ANOVA), with event type (personal vs impersonal) as the repeated measure. A similar repeated-measures ANOVA was conducted on the change in details recalled. All ANOVAs involving comparisons of the ECT treatment conditions used electrode placement (RUL vs BL) and stimulus dosage (low vs high) as between-subject factors. The covariates used in the baseline analyses were not used subsequently, since none showed associations with change in PIMT scores. Within groups, paired t tests were used to assess whether changes from baseline were significant. All tests of significance were 2 tailed, with $\alpha = .05$.

Table 1. Demographic and Clinical Features of the Sample*

	Depressed Patients (n = 55)	Normal Controls (n = 37)	P†
Age, y	53.0 (14.1)	64.4 (10.0)	.001
Female, No. (%)	32 (58)	24 (65)	.52
Education, y	13.7 (2.9)	15.0 (2.1)	.02
Verbal IQ	104.7 (15.8)	108.9 (11.3)	.17
Four-Factor Index of Social Status[43]‡	2.3 (1.0)	1.9 (0.8)	.06
Bipolar disorder, No. (%)	18 (33)		
Psychosis, No. (%)	22 (40)		
Pretreatment HRSD score	33.2 (7.7)		
Age at onset, y	38.3 (17.4)		
History of past ECT, No. (%)	18 (33)		
Duration of episode, wk§	43.4 (33.5)		
Previous affective episodes, No.‖	3.5 (3.4)		
Previous psychiatric hospitalizations, No.‖	2.1 (2.7)		

*HRSD indicates Hamilton Rating Scale for Depression; ECT, electroconvulsive therapy. Values are mean (SD) unless otherwise indicated.
†P values are the significance of the difference between patients and controls.
‡A score of 1 indicates highest socioeconomic status; 5, lowest socioeconomic status.
§Maximum of 104 weeks applied.
‖Maximum of 10 applied.

samples,[7,25] and comparisons in patients with brain damage or given ECT have been methodologically compromised. Autobiographical and impersonal memory has not been assessed in any population using tests for each domain that have equivalent structure, mnemonic demands, and psychometric properties.

Another distinction concerns memory for the occurrence of an event and for the details that comprised the event. When repeatedly retrieved, some memories take on the quality of "fact" (ie, semantic memory), in which the episodic details are lost, but the fact that the event occurred remains. For example, one may recall graduating from college at a particular time, but have no memory of the ceremony. There is substantial evidence that semantic memory can be preserved in amnesia, while episodic memory for past events is impaired.[13,23,26-28] Previous studies of the amnestic effects of ECT on public information focused on the recall of facts (eg, identification of famous people or television programs).[2,5,7,29,30] Amnesia for the details of public events has not been examined. Only one ECT study assessed memory for the details of autobiographical events,[22] and no study has assessed memory for the details of public events. It is unknown whether amnesia for details is equivalent for autobiographical and public events.

We constructed a new instrument, the Personal and Impersonal Memory Test (PIMT), which uses a structured interview to elicit memories of personal and impersonal events that occurred during the 4-year periods prior to assessment, a time frame likely to be most sensitive to the effects of ECT. Each reported event is subjectively dated for the month and year of its occurrence. Using objective criteria, each personal event is rated for its salience. Subjects also provide as many details as possible about 4 events: a recent and distant personal and impersonal event. The following represent the major aims of this study: (1) to contrast normal controls and patients with major depression in the recall of personal and impersonal events, and in the richness of the details recalled for specific events; (2) to compare the short-term effects of ECT on memory for the occurrence and details of personal and impersonal events; (3) to determine the pattern of residual deficits at 2-month follow-up; and (4) to contrast forms of ECT that differ in electrode placement and electrical dosage in short- and long-term amnestic effects.

RESULTS

COMPARISON OF PATIENTS AND CONTROLS AT BASELINE

Relative to controls, the patient group was younger (t_{90}=4.3; P<.001) and had fewer years of education (t_{90}=2.4; P=.02) (**Table 1**). The groups did not differ in sex, verbal IQ (Weschler Adult Intelligence Scale–Revised), or socioeconomic status.

Memory of Events and Event Details

The repeated-measures ANCOVA on the number of events recalled yielded a main effect of group ($F_{1,82}$=58.3; P<.001) and for the covariates age ($F_{1,82}$=8.6; P=.004) and socioeconomic status ($F_{1,82}$=4.7; P=.03) (**Figure 1**). Increasing age and lower socioeconomic status were associated with recall of fewer events. Comparisons of least-squares adjusted means indicated that the depressed group reported both fewer personal (t_{85}=5.5; P<.001) and impersonal (t_{85}=6.5; P<.001) events. In contrast, there was no indication of a group difference in detail memory. The repeated-measures ANCOVA on detail recall scores did not yield any significant effects (Figure 1).

Dating of Events and Event Salience

Both patients and controls dated the personal and impersonal events as occurring on average more than 1 year before the baseline evaluation. The repeated-measures ANCOVA did not yield significant effects, and the groups did not differ in the subjective time interval for personal events (patients: mean [SD], 18.4 [7.5] months; controls: 17.6 [4.4] months) or impersonal events (patients: mean [SD], 14.7 [6.6] months; controls: 15.7 [4.7] months). The groups also did not differ in the salience of personal events (patients: mean [SD], 1.9 [0.4]; controls: 2.0 [0.4]).

COMPARISON OF PATIENTS AND CONTROLS AFTER ECT

The 55 patients had a mean (SD) of 9.3 (2.5) treatments during the randomized phase, and completed ECT with a mean (SD) HRSD score of 13.3 (13.0). The mean (SD) post-ECT HRSD score was 4.7 (2.7) for the 31 responders and 24.5 (12.6) for the 24 nonresponders.

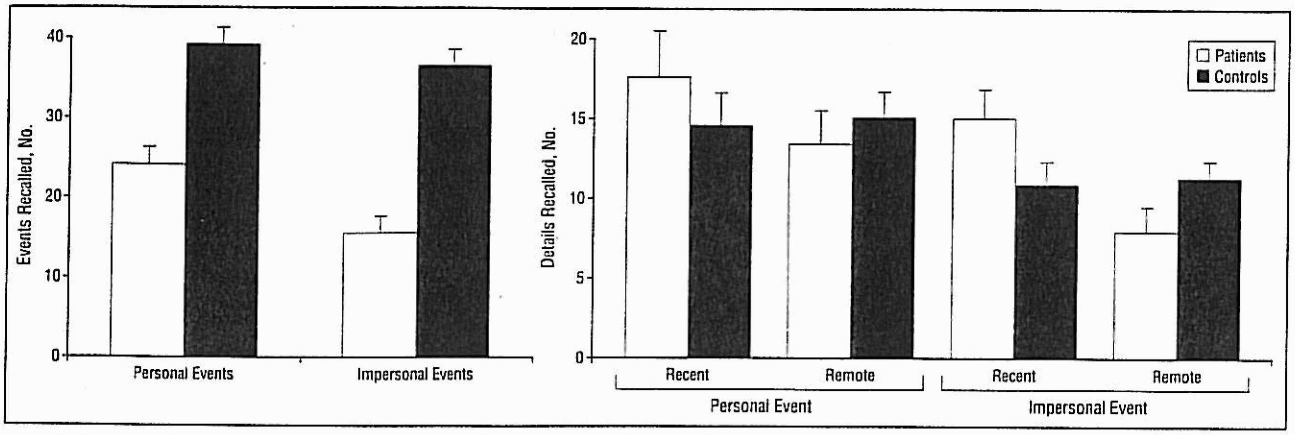

Figure 1. *Number of personal and impersonal events recalled by depressed patients (n=55) and normal controls (n=36) (left) and the number of details recalled at baseline by depressed patients and normal controls for a remote and recent personal and impersonal events (right).*

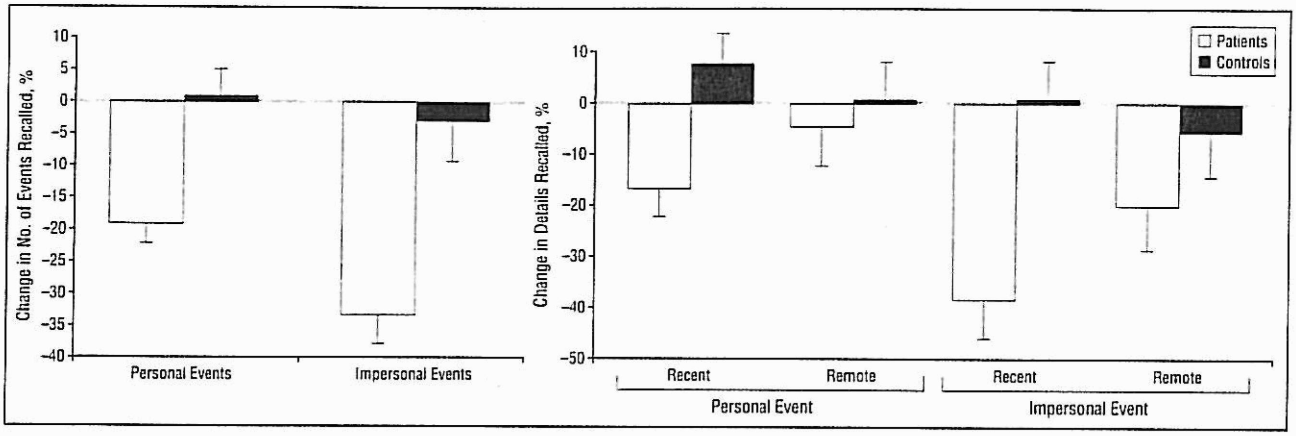

Figure 2. *Percentage change in the number of personal and impersonal events recalled by depressed patients (n=55) and normal controls (n=23) at the second (post–electroconvulsive therapy) assessment relative to baseline (left) and the percentage change in the number of details recalled for remote and recent personal and impersonal events (right). Lower scores indicated a greater reduction in event and detail recall.*

Memory of Events and Event Details

The repeated-measures ANOVA on change in event recall after ECT yielded a main effect of group ($F_{1,71}=20.1$; $P<.001$) and personal vs impersonal task ($F_{1,71}=6.0$; $P=.02$) (**Figure 2**). Compared with baseline, patients recalled both fewer personal ($t_{49}=5.8$; $P<.001$) and impersonal ($t_{49}=6.3$; $P<.001$) events, while controls had no changes in event recall. Among patients, the reduction in recall was greater for impersonal than personal events ($t_{49}=3.3$; $P=.002$).

Approximately 45% of the personal and impersonal events recalled after ECT were judged identical to those reported at baseline. Patients and controls did not differ in the percentage that matched baseline events. The reduced recall scores in patients after ECT were attributable to their reporting both fewer of the same personal ($t_{72}=5.1$; $P<.001$) and impersonal ($t_{72}=7.9$; $P<.001$) events as at baseline, and fewer new personal ($t_{72}=5.7$; $P<.001$) and impersonal ($t_{72}=7.7$; $P<.001$) events.

The repeated-measures ANOVA on detail scores produced a main effect of group ($F_{1,31}=10.0$; $P=.004$) and personal vs impersonal task ($F_{1,31}=7.1$; $P=.01$), as well as a group × event recency interaction ($F_{1,31}=4.2$; $P=.05$). Patients differed from controls in recalling details about the recent personal event ($t_{31}=3.0$; $P=.005$) and the recent impersonal event ($t_{31}=3.6$; $P=.001$) (Figure 2). Among patients, amnesia was greater for details of the recent impersonal relative to the recent personal event ($t_{28}=2.3$; $P=.03$). Among patients, the only change from baseline that did not demonstrate a significant amnestic effect was for details about the remote personal event.

Dating of Events and Event Salience

Using the date estimates provided at baseline, the groups were compared in the average subjective age of events reported at both baseline and post-ECT ("remembered events") assessments and of events reported only at baseline ("forgotten events") (**Figure 3**). A repeated-measures ANOVA for personal events produced a significant interaction between group and remembered vs forgotten events ($F_{1,69}=5.2$; $P=.03$). The groups did not differ in the baseline dating of remembered events. Personal events forgotten by patients were more distant in time than those forgotten by controls by an average of 6 months ($t_{71}=2.6$; $P=.001$). Among patients, forgotten events were dated as older than remembered events by a mean (SD) of 3.5 (8.3) months ($t_{46}=3.5$; $P=.005$), while there was no difference within the control group ($t_{21}=0.8$; $P=.43$). The repeated-measures ANOVA on the dating of remembered and forgotten impersonal events did not

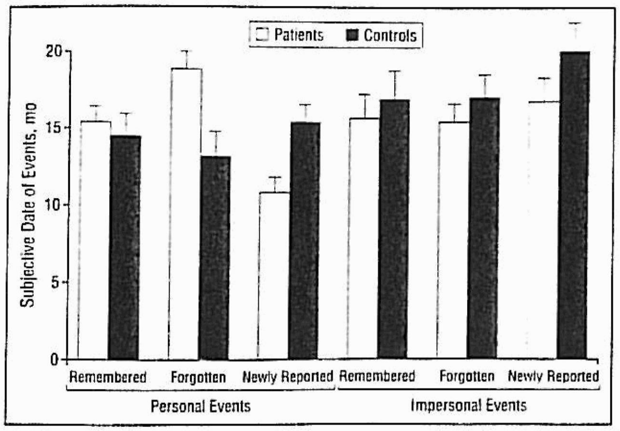

Figure 3. *Average interval of personal and impersonal events remembered, forgotten, or newly reported by depressed patients (n=55) and normal controls (n=23) at the second (post–electroconvulsive therapy) assessment. Event intervals reflected the number of months prior to the baseline assessment.*

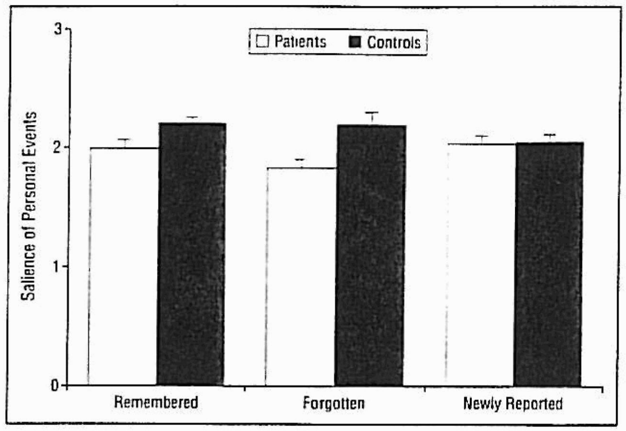

Figure 4. *Average salience ratings of personal events remembered, forgotten, or newly reported by depressed patients (n=55) and normal controls (n=23) at the second (post–electroconvulsive therapy) assessment.*

produce significant effects. The groups were also compared for the average age of new events reported after ECT and dated at that assessment (Figure 3). A repeated-measures ANOVA produced main effects of group ($F_{1,60}$=6.1; P=02) and personal vs impersonal tasks ($F_{1,60}$=13.5; P=.0005). Across the sample, newly reported personal events were more recent than new impersonal events. Across the 2 task components, new events reported by patients were more recent than new events reported by controls.

The repeated-measures ANOVA on salience ratings for personal events remembered and forgotten post-ECT yielded a main effect of group ($F_{1,71}$=6.6; P=.01) (**Figure 4**). Patients and controls did not differ in salience ratings for remembered events ($F_{1,71}$=2.5; P=.12), but patients had lower ratings for forgotten events ($F_{1,71}$=6.9; P=.01). Among patients, forgotten events were rated as less salient than remembered events (t_{40}=2.0; P=.05), while there was no difference within the control group (t_{22}=0.1; P=.92). Patients and controls did not differ in the salience ratings for personal events newly reported after ECT (t_{76}=0.1; P=.92) (Figure 4).

COMPARISON OF PATIENTS AND CONTROLS AT 2-MONTH FOLLOW-UP

Thirty-three of 55 patients completed the 2-month follow-up. The principal reason for loss to follow-up was geographical distance. Patients completing follow-up did not differ from nonparticipants in the clinical and demographic features in Table 1; ECT modality in the randomized phase; post-ECT HRSD scores and response rate; HRSD score at 2-month follow-up (participants: mean [SD], 8.3 [6.6]; nonparticipants: mean [SD], 8.2 [8.0]); and PIMT scores at baseline and post-ECT assessments. No differences were detected between controls who completed (n=19) and those who did not complete (n=17) the 2-month follow-up assessment.

Event recall and detail recall memory scores were substantially improved in the patients sample at the 2-month follow-up (**Figure 5**) relative to the post-ECT assessment (Figure 2), indicating recovery from amnesia. The repeated-measures ANOVA on the event recall measures only yielded a trend for a main effect of personal vs impersonal tasks ($F_{1,46}$=3.5; P=.07). Although the group × task interaction did not achieve significance ($F_{1,46}$=1.94; P=.17), patients and controls had identical change scores for personal events, but patients continued to have a deficit in recall of impersonal events. Within the patient sample, recall scores at the 2-month follow-up were poorer for impersonal than personal events (t_{30}=2.5; P=.02).

The repeated-measures ANOVA on detail recall scores only produced a trend for a main effect of event recency ($F_{1,13}$=4.0; P=.06) (Figure 5). Among patients, the change in detail memory differed from baseline only for recent impersonal events (t_{11}=4.0; P=.002), and these amnesia scores were greater than those for the recent personal event (t_{11}=2.8; P=.02).

COMPARISON OF TREATMENT CONDITIONS AFTER ECT

Memory of Events and Event Details

The ECT treatment conditions did not differ in baseline measures of total event or detail recall. The repeated-measures ANOVA on event recall scores yielded main effects of electrode placement ($F_{1,46}$=23.7; P<.001) and personal vs impersonal tasks ($F_{1,46}$=9.3; P=.004), and an interaction between electrode placement and personal vs impersonal task factors ($F_{1,46}$=7.1; P=.01). Relative to RUL ECT, BL ECT resulted in reduced recall of both personal ($F_{1,46}$=9.2; P=.004) and impersonal ($F_{1,46}$=23.2, P<.001) events (**Figure 6**). Furthermore, the relative deficit in memory for impersonal compared with personal events was observed only among patients treated with BL ECT. Electrical dosage condition had no effect on event recall. To determine whether the treatment group differences were attributable to differences in clinical outcome, the ANOVA was repeated, adding the percentage change in HRSD scores over the treatment course as a covariate. The results were unaltered, and there were no effects involving clinical improvement. Responders and

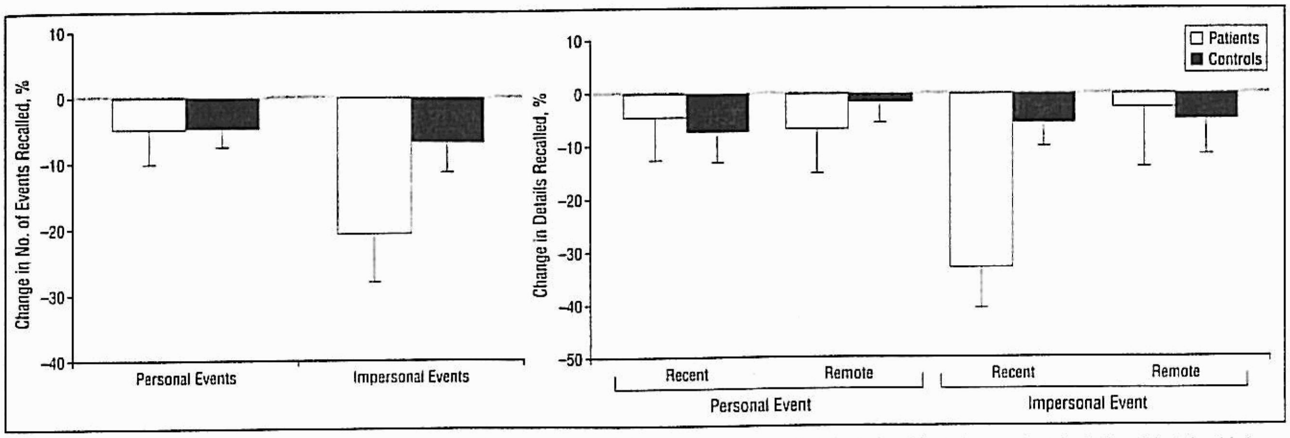

Figure 5. *Percentage change in the number of personal and impersonal events recalled by depressed patients (n=33) and normal controls (n=19) at the third (2-month follow-up) assessment relative to baseline (left) and the percentage change in the number of details recalled for remote and recent personal and impersonal events (right). Lower scores indicated a greater reduction in event and detail recall.*

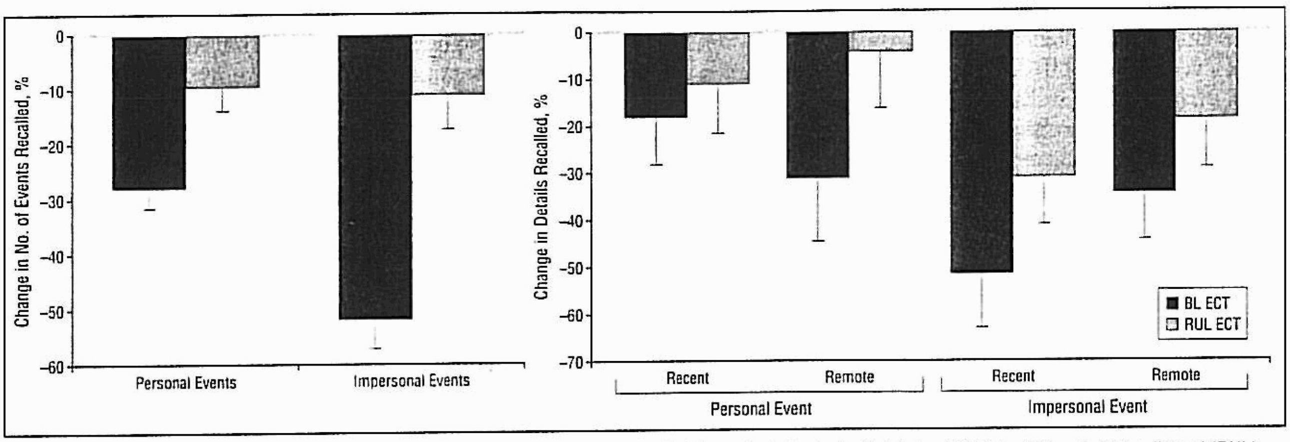

Figure 6. *Percentage change in the number of personal and impersonal events recalled by patients treated with bilateral (BL) (n=31) and right unilateral (RUL) electroconvulsive therapy (ECT) (n=24) at the second (post-ECT) assessment relative to baseline (left) and the percentage change in the number of details recalled for remote and recent personal and impersonal events (right). Lower scores indicated a greater reduction in event and detail recall.*

nonresponders were also compared with *t* tests for change in the recall of personal and impersonal events. No effect approached significance.

The repeated-measures ANOVA was conducted on the percentage of personal and impersonal events reported after ECT that were consistent with baseline; only the main effect of electrode placement was significant ($F_{1,41}$=7.6; *P*=.009). The percentage of remembered personal and impersonal events was lower with BL ECT (personal: mean [SD], 39.1 [22.5]; impersonal: mean [SD], 36.1 [29.6]) than RUL ECT (personal: mean [SD], 53.6 [18.3]; impersonal: mean [SD], 47.6). The repeated-measures ANOVA on the number of new personal and impersonal events reported after ECT yielded a main effect of electrode placement ($F_{1,41}$=7.6; *P*=.009). Patients treated with BL ECT also reported fewer new personal and impersonal events ($F_{1,45}$=4.2; *P*=.05), and the total patient sample reported fewer new impersonal than personal events ($F_{1,45}$=8.9; *P*=.005).

The repeated-measures ANOVA on changes in detail recall yielded main effects of personal vs impersonal events ($F_{1,13}$=4.7; *P*=.049) and event recency ($F_{1,13}$=4.7; *P*=.04), as well as interactions between electrode placement and recency ($F_{1,13}$=4.5; *P*=.05) and electrode placement, personal vs impersonal events, and recency ($F_{1,13}$=4.6; *P*=.05) (Figure 6). For each of the 4 events, the BL ECT group recalled fewer details than patients treated the RUL ECT group. Although the greatest impairment in both groups was for details of the recent impersonal event, the difference between the electrode placement for BL and RUL ECT was most marked for the remote personal event ($F_{1,13}$=4.7; *P*=.049). Electrical dosage condition, degree of clinical improvement, and responder status were not associated with the change in detail recall for any of the 4 events.

Dating of Events and the Salience of Personal Events

The repeated-measures ANOVA on the subjective dates for remembered and forgotten personal events indicated that, across the patient sample, remembered personal events occurred closer in time to ECT than forgotten personal events ($F_{1,44}$=9.6; *P*=.003). There were no effects involving treatment conditions. No effects were significant in the analysis of the subjective dating of remembered and forgotten impersonal events. The repeated-measures ANOVA on the dating of new personal and impersonal events yielded a main effect of electrode placement ($F_{1,34}$=4.6; *P*=.04) and personal vs impersonal tasks ($F_{1,34}$=13.3; *P*=.0009). New impersonal events

Table 2. Correlation Between Total Recall and Amnesia Scores on the Personal and Impersonal Memory Test (PIMT) and Total Recall and Amnesia Scores on the Autobiographical Memory Interview (AMI)*

	All Items				Past-Year Items			
	AMI Recall		AMI Amnesia		AMI Recall		AMI Amnesia	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
PIMT Personal Component								
Baseline (*df* = 50)	0.64	<.001	...	...	0.60	.001	...	...
After ECT (*df* = 50)	0.72	<.001	0.61	<.001	0.63	.001	0.57	<.001
2-Month follow-up (*df* = 29)	0.68	<.001	0.36	.04	0.60	.0004	0.48	.006
PIMT Impersonal Component								
Baseline (*df* = 46)	0.48	.0005	...	...	0.51	.0002	...	...
After ECT (*df* = 46)	0.56	<.001	0.47	.0008	0.46	.001	0.44	.002
2-Month follow-up (*df* = 27)	0.65	<.001	0.47	.01	0.69	<.001	0.38	.04

Ellipses indicates that the test was not performed; ECT, electroconvulsive therapy.

were dated as more remote from ECT than new personal events. This effect was most marked among patients treated with BL ECT ($F_{1,34}$=4.9; P=.03).

A repeated-measures ANOVA on the salience ratings of remembered and forgotten personal events did not produce significant effects, nor did an ANOVA on the salience ratings of new personal events.

COMPARISON OF TREATMENT CONDITIONS AT 2-MONTH FOLLOW-UP

Of the 33 patients retested at follow-up, 7 had a course of RUL ECT, 14 received a course of BL ECT, and 12 received a mean (SD) of 9.5 (2.6) crossover high-dosage BL treatments after not responding to RUL ECT (n=8) or BL ECT (n=4) in the randomized phase. The 3 subgroups did not differ in HRSD scores at completion of ECT or at the follow-up evaluation. These 3 subgroups were compared for changes in the recall of events and details. The total number of treatments (randomized and crossover) was unrelated to amnesia scores at the 2-month follow-up for the personal (r_{31}=0.26; P=.15) and impersonal (r_{29}=0.12; P=.50) event recall components.

Repeated-measures ANOVA on event recall scores yielded a main effect of personal vs impersonal tasks ($F_{1,28}$=5.0; P=.03). Across the patient sample, impersonal events were recalled at a lower rate than personal events. Within each of the subgroups, there was no change from baseline in the number of personal events recalled. Patients treated with BL ECT, either as a single course in the randomized phase (t_{13}=2.0; P=.07) or as crossover treatment (t_{11}=2.3; P=.04), had reduced recall of impersonal events relative to baseline. Patients treated with a single course of RUL ECT were unchanged in this measure (t_6=0.3; P=.80).

The ANOVAs conducted on the detail recall scores did not yield significant effects of treatment condition, perhaps because of the small sample size for these measures. Nonetheless, the only significant within-group changes from baseline pertained to the recent impersonal event for patients treated with BL ECT. Relative to baseline, patients treated with BL ECT as a single course (t_4=2.8; P=.049) or as crossover treatment (t_4=4.4; P=.01) had reduced recall of the details of the recent impersonal event.

RELIABILITY AND VALIDITY OF THE PIMT

Across the sample of patients and controls, Cronbach α was computed to derive internal reliability estimates separately for total recall scores for the personal and impersonal components of the PIMT. For the personal component, the values were 0.67, 0.84, and 0.78, at the baseline, post-ECT, and 2-month follow-up assessments, respectively, and for the impersonal component, were 0.84, 0.83, and 0.83, respectively. Thus, both components had comparable and strong internal reliability.

Test-retest reliability was examined by computing the correlations across the sample of patients and controls between total recall scores at the different points. For the PIMT personal component, baseline recall scores were substantially associated with post-ECT (r_{77}=0.75; P<.001) and 2-month follow-up (r_{50}=0.69; P<.001) scores. Baseline recall scores for the impersonal component were also strongly associated with post-ECT (r_{72}=0.76; P<.001) and 2-month follow-up (r_{46}=0.72; P<.001) scores. Thus, despite the variable effects of ECT among patients, PIMT recall scores showed strong retest reliability.

To test the reliability of subjective dating, the correlation was computed within each subject between the age of remembered events dated at both baseline and post-ECT assessments. For personal events, the median correlations for patients and controls were 0.89 and 0.84, respectively, and for impersonal events, were 0.88 and 0.82, respectively. Subjective dating showed strong retest reliability and, in the case of patients, despite the intervention with ECT.

In the patient sample, PIMT total recall and amnesia scores showed strong associations with comparable AMI measures (**Table 2**). The magnitude of these associations was unaltered when AMI scoring was restricted to events that occurred in the previous year (Table 2) or those corroborated by significant others (data not shown). Thus, the PIMT showed strong concurrent validity.

COMMENT

This study found that ECT results in greater and more persistent deficits for public (impersonal) than autobiographical (personal) events. This demonstration was based on several findings. Shortly after ECT, patients had a greater deficit in the recall of impersonal than personal events. Two months after ECT, patients did not show a change from baseline in the recall of personal events or differ from normal controls in this change, but they had reduced recall of impersonal events. These findings were mirrored in the analysis of memory for event details. Shortly after ECT, patients recalled fewer details about recent relative to remote events. This effect was greater for the recent impersonal than the recent personal event. Two months after ECT, the only residual impairment in memory for event details among patients concerned the recent impersonal event.

The analysis of ECT treatment conditions supported this differential impairment. As in previous studies,[7,11,38] BL ECT produced greater and more persistent amnestic effects than RUL ECT. At both the short- and long-term time assessments, the amnestic effects of BL ECT were especially pronounced for recalling of impersonal events and the details of the recent impersonal event. The symmetry in findings regarding the differences between the patient and control samples and the effects of electrode placement within the patient sample provided internal validation of this differential deficit.

The differential impairment in the recall of autobiographical and impersonal information supports, but does not prove, a dissociation in the memory systems that subserve these forms of knowledge.[15,27,28] Alternatively, various types of event (episodic) and fact (semantic) memory may be subserved by the same medial temporal lobe system.[44] The differential impairment obtained here may be attributable to less deep encoding at acquisition, less frequent retrieval, and/or less personal significance for memories of public events. The findings regarding objective salience provided indirect support for this view. After ECT, forgotten personal events had lower objective salience than remembered events. Therefore, it seemed that less important personal events were more likely to be forgotten; it may be a fair assumption that impersonal events may generally be of lesser importance to the individual than personal events.[17] Furthermore, the fact that PIMT amnesia scores for both personal and impersonal events also correlated substantially with AMI scores suggests that a common mechanism subserves ECT-induced amnesia for both types of events.

In line with traditional views,[1,5,45] this study supported the notion that a temporal gradient characterizes the memory deficits after ECT, but obtained conflicting evidence on the nature of this gradient. Amnesia for event details showed a consistent effect of event recency, with memory for the details better preserved for remote than recent personal and impersonal events. However, contrary to the view that the most recent memories are most vulnerable to amnesia, the personal events that patients failed to recall after ECT were dated at baseline as having occurred on average 6 months earlier than the personal events forgotten by controls (Figure 3). The opposite would have been expected if ECT affects preferentially on the youngest memories. The reason for this discrepancy is unknown and, with subjective dating, forgotten impersonal events did not show a consistent temporal pattern. The task examining memory for details selected events at the extremes of the 4-year period, and this may explain why consistently greater amnesia was found for the recent events. The findings obtained with subjective dating raise the possibility that the period vulnerable to amnesia after ECT has a temporal gradient, but extends further back in time than is often described.[1,12,45] Amnesia for event details also showed a consistent effect of event recency, with memory for the details of remote personal and impersonal events better preserved than memory for recent events.

At baseline, depressed inpatients had a marked deficit in the number of personal and impersonal events they recalled. This deficit could result from a paucity of personal or impersonal events because of restricted activity, deficient acquisition because of impaired learning,[46,47] or defective retrieval.[48,49] The fact that at 2-month follow-up patients only returned to their baseline absolute level of personal event recall, never matching that of controls, could imply a hidden iatrogenic ECT effect. Comparison of an ECT and pharmacologically treated samples is needed to test this possibility.

This study had several limitations. A novel instrument was used, and the reporting of event dating and details was not corroborated. Nonetheless, the PIMT showed strong internal and retest reliability, with the personal and impersonal components equivalent in psychometric properties; subjective dating also had strong reliability. Despite this, there may have been intrinsic differences in task difficulty for the recall of personal and impersonal events. Most critically, PIMT amnesia scores correlated substantially with AMI amnesia scores, and the occurrence of events had been corroborated for the AMI.

This study used a healthy comparison group. Arguably, a pharmacologically treated patient comparison group would have been advantageous. Such a group could control for changes in recall caused by the clinical state and for pharmacological treatment at the long-term follow-up. However, unless patients are randomized to ECT and pharmacological treatment, there are concerns. When ECT and pharmacologically treated patients have been matched in HRSD scores at baseline, ECT samples have greater representation of melancholic features,[29] poorer neuropsychological performance,[29] and greater functional impairment.[50] It is also unlikely that ECT and pharmacologically treated patients would display the same speed and quality of clinical improvement over time.[51,52] The use of a healthy comparison group had the advantage of demonstrating that the extent of memory loss recall for personal events at long-term follow-up was equivalent in the total sample of ECT-treated patients and normal control samples. However, the small sample size in the comparisons of the treatment subgroups at long-term follow-up was another limitation.

Electroconvulsive therapy candidates are often especially concerned about the extent and nature of personal memory loss. This study suggests revision of the information conveyed to patients.[12] Memory of public events will be more disrupted than memory of autobiographical events. Events closest in time to the administration of ECT seem to be most vulnerable. Personal events of less objective significance are more likely to be forgotten than higher salience events. Amnesia for the details of events (ie, the richness of memory) follows the same pattern as amnesia for the occurrence of events. Bilateral ECT results in more profound and persistent impairment than RUL ECT, and the effects of ECT on memory of personal and public events are independent of therapeutic response.

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Reprints: Sarah H. Lisanby, MD, Department of Biological Psychiatry, New York State Psychiatric Institute, 1051 Riverside Dr, Box 126, New York, NY 10032 (e-mail: SHL24@columbia.edu).

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COMMENTARY

Retrograde Amnesia With Electroconvulsive Therapy

Characteristics and Implications

SINCE ITS beginning, more than 60 years ago, it has been recognized that electroconvulsive therapy (ECT) (ie, the electrical induction of a series of grand mals–type seizures for therapeutic purposes) is often associated with amnesia; this amnesia represents the most bothersome side effect to many individuals who receive this treatment.[1] The phenomenologic characteristics of ECT-associated amnesia are reminiscent of many other types of organic amnesia, in that it typically consists of difficulties in retention of both newly learned material (anterograde amnesia) and past events (retrograde amnesia [RA]).[2] Retrograde amnesia is generally believed to be the more problematic than anterograde amnesia with ECT, at least as far as long-lasting effects are concerned.[3,4]

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Two types of RA can occur with ECT (ie, difficulty in recall of autobiographic and impersonal material), which differ largely on the extent of personal reference. For the most part, this distinction follows the episodic vs semantic memory dichotomy,[5] but these relationships are most likely more complex. Although more difficult to assess than anterograde amnesia, RA has been the focus of a modest number of ECT studies, beginning with the seminal work of Janis and Astrachan[6] in the 1950s, which firmly established that sine wave, bilateral (BL) ECT was associated with both acute and persistent deficits in autobiographical memory. This work has since been extended by others, indicating the following: (1) ECT produces deficits in both autobiographic and impersonal memory domains; (2) these losses improve substantially after completion of an ECT course but residual difficulties persist in some patients; (3) the severity and persistence of RA is greater with BL stimulus electrode placement than with unilateral (UL) nondominant placement, and with sine wave stimuli than with pulse stimuli; (4) the extent of RA is not significantly correlated with degree of therapeutic improvement; and (5) the relationship between objective measures of RA and subjective (self-rated) RA indexes is complex, with the latter tending to be more highly correlated with therapeutic outcome than with objective test results.[7-12]

Throughout this literature, there has been the presumption that autobiographic memories are more likely to be adversely affected with ECT than impersonal memories. In part, this view seems to be based on patient reports, which can be expected to be biased toward material that has a personal reference. In addition, prior work in this area has been flawed by the absence of psychometric equivalence between tasks assessing autobiographic and impersonal memory function. The present investigation by Lisanby and colleagues[13] represents an attempt to clarify the effects of ECT on both types of RA by using a new instrument (the Personal and Impersonal Memory Test), which incorporates psychometrically matched tasks; in addition, it allows a comparison between autobiographic and impersonal memory with respect to a number of characteristics. These include recall of event occurrence vs recall of details, recency effects (ie, how long before ECT the event took place); saliency (a measure of presumed importance to the subject); ECT technique (stimulus electrode placement, stimulus intensity, and number of ECT treatments); and persistence of RA over a 2-month period. Lisanby and coworkers[13] also provide a comparison between forgetting of autobiographic and impersonal memories by individuals receiving ECT with that experienced over a similar interval by a normal control group.

In addition to a wealth of other important findings, these investigators found that, in contrast to earlier, less methodologically rigorous work in this area, impersonal memories seemed to be affected more than autobiographic memories both immediately and 2 months after a course of BL ECT. As noted by the authors, this finding indicates that consent discussions of RA with patients referred to ECT should not focus only on potential autobiographic effects.[14]

Retrograde amnesia was present only with BL ECT subjects, not those receiving UL ECT. Bilateral, but not UL, ECT subjects also demonstrated a slight persistence of RA for impersonal, but not autobiographic, material at 2 months after ECT. Other investigations have varied in the existence of persistent RA on the basis of objective test results[7,9-12,15]; we have, for example, reported RA for autobiographic material at 6 months after BL (but not UL) ECT.[8] In this regard, because an infrequent occurrence of more substantial persistent RA might not be apparent in pooled data, it would not be appropriate to tell patients, regardless of stimulus electrode placement, that such effects cannot occur.

As opposed to these electrode placement effects, no relationship was found between RA and stimulus dose, at least within this study's range, which did not exceed 2.5 times seizure threshold.[13] This observation supports consideration of increases in stimulus dose, which the same group has shown is associated with improved treatment efficacy,[10] as a possible alternative to switching to BL ECT in UL ECT nonresponders, particularly for individuals who have already developed or who fear developing ECT-related cognitive impairment. However, more work is necessary to establish whether this absence of stimulus-related effects holds for high-intensity stimuli.

The incorporation of a normal control group not only allows an investigation of how "normal forgetting" differs from that which occurs with ECT, but also reflects the amnestic deficits that are frequently present with major depression.[9,11] It is not surprising that recall of both autobiographic and impersonal event occurrence before ECT in these depressed patients is less than that displayed by nondepressed control subjects. It is also known that residual depressive symptoms can also be a factor in poor memory performance after ECT.[7] To what extent such amnestic effects might persist on a trait basis for patients in remission from a depressive episode awaits further exploration by studies incorporating both ECT and non-ECT subject groups with major depression. Elderly individuals, in whom the additive effects of incipient degenerative brain disease may be associated with an increased risk of developing major depression,[16] may be particularly at risk in this regard.

As a final point, forgetting, whether it be in terms of autobiographic or impersonal memories, is part of the human experience and is influenced by many factors, not just the occurrence of mental illness, such as major depression, or the use of a particular treatment, such as ECT. However, RA in the context of such clinical situations offers the potential of furthering our understanding about how memory works, both from a cognitive perspective[5] and in terms of underlying neurobiology.[17] The differential effects of ECT on autobiographic and impersonal memory found by Lisanby and colleagues[13] are of interest in this regard, as are other findings dealing with memory recency and the effects of variations in the placement of stimulus electrodes. What such observations tell us about memory processes themselves is an area also worthy of further exploration.

Richard D. Weiner, MD, PhD
Department of Psychiatry and Behavioral Sciences
Duke University Medical Center
Mental Health Service Line
Department of Veterans Affairs Medical Center
Box 3309, DUMC, Durham, NC 27710
(e-mail: rweiner@duke.edu)

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