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Short- and Long-Term Cognitive Effects of ECT: Part II—Effects On Nonmemory Associated Cognitive Functions.

Trevor R.P. Price, M.D.[1]

In addition to the multiple effects that electroconvulsive therapy (ECT) has on memory function, which were reviewed in the preceding article (Price, 1982), it likewise has a variety of effects on cognitive functions which are largely independent of memory. The range of cognitive domains affected include, for example, perceptual function, psychomotor speed, visuomotor ability, simple and complex sensory capacity, complex discrimination ability, and synthesizing and abstracting ability (Fink, 1979). This article will review these effects of ECT.

To understand ECT's effects on memory function or nonmemory-associated cognitive and neuropsychological function, it is important to

[1]Department of Psychiatry, Dartmouth Medical School, Hanover, NH 03755.

keep in mind that the diseases for which ECT finds its principal use, i.e., major depressive disorder and schizophrenia, may themselves be responsible for significant deviations from the norm in these functions. Thus the problem of how much of an observed cognitive impairment is due to the treatment as opposed to the underlying disease again confronts the clinician. For a more detailed discussion of this issue, the reader is referred to the discussion by Nasrallah in this series.

Nonmemory Cognitive Impairments Associated with Depression

Depression may be associated with nonmemory-associated cognitive dysfunctions, ranging from impaired concentration and attention (Wohlberg & Kornetsky, 1973) to a state-dependent delirium with mild to moderate, diffuse, generalized impairment on the Halstead-Reitan battery (Donnelly, Dent, & Murphy, 1972; Goldstein, Filskov, Weaver, & Ives, 1977) to the clinical picture of a profound pseudodementia with gross cognitive impairment and marked general function disability (Wells, 1979; Cavenar, Maltbie, & Austin, 1979). Unfortunately, the research literature in this area is inconsistent and at times even somewhat contradictory. For example, Small, Small, Milstein, and Moore (1972) reported no evidence of diffuse of localized neuropsychological dysfunction on Halstead-Reitan testing in a cohort of psychotically depressed patients but, subsequently, in a followup study of the same patients, reported improvement in some right hemispheric functions with ECT, suggesting the likely presence of an unrecognized asymmetric abnormality prior to treatment (Small, Small, Milstein, & Sharpley, 1973). Several other workers have also reported right hemispheric, particularly frontal, abnormalities (Tucker, Stenslie, Roth, & Shearer, 1981; Kronfol, Hamsher, Digre, & Waziri, 1978; Goldstein et al., 1977), as well as atypical patterns of hemispheric activation (Moscovitch, Strauss, & Olds, 1981) and impaired ability to learn new material (Campbell, 1957), to note just a few of the many different types of cognitive dysfunction that may be associated with depression.

Despite these interesting and provocative preliminary findings, thus far no characteristic patterns of cerebral dysfunction of hemispheric asymmetry occurring in association with depression have been clearly established (Marin & Tucker, 1981).

Cognitive Impairment Associated with Schizophrenia

In patients with schizophrenia, a variety of nonmemory-associated cognitive impairments have been found. As with depression, impaired attention and concentrating ability are common (Wohlberg & Kornetsky, 1973), as is diffuse cognitive dysfunction as assessed by the Halstead-Reitan battery as well as other tests of neuropsychological function (DeWolfe, Barrell, Becker, & Spaner, 1971; Watson, 1971). Wexler (1980) described specific left hemispheric dysfunction in schizophrenia in his review of the literature on cerebral laterality and psychiatric illness. Others (Taylor, Greenspan, & Abrams, 1979; Newlin, Carpenter, & Golden, 1981) have reported similar findings. However, Marin and Tucker (1981) and Merrin (1981) note that while some studies seem to support the notion of specific left hemispheric dysfunctions in schizophrenia, a variety of others do not. They also point out the existence of a variety of methodologic shortcomings in many of the studies that have been done in this area.

Methodological and Technical Issues

In view of the foregoing, it is clear that any research on the nonmemory-associated cognitive effects of ECT must be designed and executed so as to carefully control for and, as much as possible, eliminate the following confounding factors.

First, one must anticipate finding impaired attention and concentration as well as diffuse cognitive dysfunction in both depressives and schizophrenics. Next, presumed lateralized ECT-induced cognitive changes must be interpreted in the light of the evidence that suggests there may be differential right hemispheric dysfunction in depression and left hemispheric dysfunction in schizophrenia. One must attempt to control for patient age, treatment with psychotropic medication, intelligence quotient (IQ), education, and severity of illness, given the potentially important

impact each of these may have on various cognitive functions. It is thus important that studies of the effects of ECT on cognition include age- and IQ-matched, comparably ill, medication-free, patient controls as well as normal controls.

It is also crucial to design cognitive test batteries with the practice effect in mind. Finally, in this type of research it is important to determine accurately hemispheric dominance, since just giving right unilateral ECT to all patients can result in stimulation over the dominant hemisphere in as many as 10% of cases even among strong right-handers (Clyma, 1975). Testing for dysphasia after ECT (Warrington & Pratt, 1973; Pratt & Warrington, 1972) and using the handwriting test (Levy & Reid, 1976), in addition to administering standard handedness questionnaires, can significantly increase the accuracy of determining cerebral dominance.

General Principals Regarding the Effects of ECT on Nonmemory-Associated Cognitive Function

In general, the literature during the 1940s and 1950s on nonmemory-associated cognitive effects of ECT was somewhat more extensive than that regarding the effects of ECT on memory. However, interest in this area waned in the 1960s and 1970s, though in very recent years there appears to have been a resurgence of research interest in this area in conjunction with the growth of interest in topics such as the laterality of cerebral functions, the neuropsychological abnormalities associated with various types of psychopathology, and the differential effects of dominant and nondominant unilateral ECT.

Fink (1979) reported that ECT-induced impairments in certain neuropsychological functions, e.g., perceptual acuity and psychomotor speed, are proportional to the number and frequency of seizures induced. As is the case with memory dysfunction, ECT-induced cognitive dysfunction may be delayed in its onset for up to 24 hours (Hargreaves, Fischer, Elashoff, & Blacker, 1972). Further, it has been reported that the impairments in nonmemory-associated cognitive functions are maximal at the time of the seizure and rapidly revert to pretreatment levels or better during the 14 days following the last seizure. Some evidence suggests that there is a cumulative effect on certain cognitive measures, such as the verbal Wechsler Adult Intelligence Scale (WAIS). Thus, Squire (1975) reported that the verbal WAIS had returned to normal within 40 minutes of the first bilateral ECT in a series, but took up to 48 hours to return to normal after the sixth. Three other studies suggested that with unilateral ECT, performance on a variety of psychological tests deteriorates progressively up to the fifth treatment, then improves despite continued treatment (Small & Small, 1971; Scanlon & Mathas, 1967; Fink, Kahn, Kapp, et al., 1961). Not surprisingly, simple cognitive and neuropsychological functions tend to be less severely disrupted and to return to baseline more rapidly than do complex ones.

In addition to the general changes in neuropsychological function already mentioned, ECT can cause topographical disorganization and disorientation (A Practicing Psychiatrist, 1965). Another interesting but as yet unexplained finding is that the number of errors on the Benton Visual Retention Test correlates highly with the degree of rise in blood pressure that occurs during ECT (Hamilton, Stocker, & Spencer, 1979). Furthermore, analogous to its effects on memory, unilateral dominant ECT has been reported to have greater effects on verbalization than is the case with unilateral nondominant ECT (Pratt & Warrington, 1972). Curiously, patients who have had unilateral dominant or bilateral ECT have been found to have greater difficulty with picture recognition than those who received unilateral nondominant ECT (Halliday, Davison, Browne, & Kreeger, 1968). This is thought to be due to the important influence verbal functions play in encoding visual stimuli (Williams, 1973), a role perhaps even more important than that of visual perceptual factors.

Unlike memory functions, there has been a relative paucity of investigation of the relationship between nonmemory-associated cognitive functions and stimulus intensity and waveform, the location (laterality) of stimulation, and the interaction between the cognitive effects of ECT and patient age, IQ, and sex. In fact, it has only very recently become apparent that the last-mentioned of these variables may be important in relation to general cognitive functioning (Miller, Small, Milstein, et al., 1981; Inglis & Lawson, 1981).

The Clinical Spectrum of ECT-Induced Nonmemory-Associated Cognitive Dysfunctions

Post-ECT cognitive dysfunctions span a broad spectrum of clinical presentations ranging from no apparent dysfunction to mild delirium with confusion all the way to gross delirium with flagrant organic psychotic features.

Post-ECT Confusion

Since post-ECT confusion is so frequently seen, it has, not surprisingly, been studied by a number of researchers over the years. Unfortunately, many of the articles dealing with it have failed to provide adequate operational definitions of "confusion" and have not established objective criteria for quantitative measurement of it. Despite these shortcomings, there seems to be a general consensus in these studies that bilateral ECT causes a greater degree of confusion and confusional behavior than unilateral ECT (Lancaster, Steinert, & Frost, 1958; Cannicott, 1962; Impastato & Karliner, 1966). Impastato and Karliner (1966) further reported that the degree of confusion occurring after unilateral nondominant ECT was less than that observed after unilateral dominant ECT. Consistent with this finding was that of Abrams (1967), who reported that neither confusion nor confusional behavior occurred after unilateral nondominant ECT, even when it was given on a daily basis for a large number of treatments.

Some researchers seeking to quantify the somewhat nebulous notion of confusion have employed as an objective measure the amount of time necessary after ECT for patients to regain full orientation to person, place, and time. Using this operational definition, several workers including Valentine, Keddie, and Dunne (1968); Halliday et al. (1968); Sutherland, Oliver, and Knight (1969); and d'Elia (1970) have replicated and confirmed the qualitative findings of earlier studies that unilateral ECT is followed by more rapid reorientation, and therefore less confusion, than is bilateral ECT. Fraser and Glass (1978, 1980) using a quantitative index of recovery after ECT that included, among other measures, orientation time, found that recovery was more rapid after unilateral nondominant than after bilateral ECT. Furthermore, they found that the recovery time after bilateral but not unilateral nondominant ECT increased as the course of treatment progressed, especially if the interval between treatments was shorter, e.g., 1 day, as opposed to 2 or 3 days. They also found that recovery times were longer in elderly as opposed to young patients with both unilateral and bilateral treatment modes. The differences were five times greater with unilateral and nine times greater with bilateral ECT.

Several other related studies have confirmed the fact that reorientation occurs considerably more rapidly after unilateral nondominant than unilateral dominant or bilateral ECT (Halliday et al., 1968; Sutherland et al., 1969; Wilson & Gottlieb, 1967; Cronin, Bodley, Mather, et al., 1970; d'Elia, 1970).

As is true with memory dysfunction following ECT, post-ECT confusion does not have prognostic implications as far as treatment outcome is concerned, nor is it a necessary concomitant of affective improvement. Thus, Wilcox (1953) found that there was no relationship between prolonged confusion after the first ECT, nor the degree of cumulative confusion after the tenth ECT in a series, and the results of a full course of ECT, either in respect to affective or cognitive outcome.

Acute Organic Mental Syndromes

ECT-induced acute organic mental syndrome, as it is currently known, is a clinical syndrome characterized by variable symptomatology ranging from mild confusion and bewilderment to grossly psychotic signs and symptoms in association with global cognitive impairment. It was first described in 1945 by Kalinowsky and has since been reported in a number of studies (Gallinek, 1952; Ottosson, 1968; Elmore & Sugerman, 1975; Arnot, 1975; Summers, Robins, & Reich, 1979; Fink, 1979; Marshall, Kalin, & Tariot, 1980).

This syndrome may be characterized by any or all of the following: difficulty concentrating, gross disorientation and confusion, a sense of perplexity and bewilderment, perseveration and circumstantiality, aphasic and apraxic symptoms, facial and body dysgnosias, and hallucinations and delusions (Kalinowsky, 1945). Typically such

episodes clear suddenly and, according to Kalinowsky (1945), they frequently clear within 7 to 10 days of their onset.

In a recent series (Summers et al., 1979), 40% of patients receiving bilateral ECT developed acute organic mental syndromes. These varied in severity, developed after a mean of 5.5 bilateral ECTs, had a mean duration of 20.1 days, and were seen more frequently in patients with a history of major medical illness or in patients who were on psychotropic drugs, especially drugs having anticholinergic effects. The last finding, of course, is consistent with the widespread clinical experience that ECT and anticholinergic agents may have additive deliriogenic effects. Similarly, a number of recent reports (Ayd, 1981; Mandel, Madsen, Miller, & Baldessarini, 1980; Small, Kellams, Milstein, & Small, 1980; Weiner, Whanger, Erwin, & Wilson, 1980) indicate that ECT and lithium in combination may have a particular propensity in some, but not all, patients to cause reversible acute organic mental dysfunction.

Fink (1974) has reported an increased frequency of acute organic mental syndromes with increased numbers and frequency of bilateral ECTs. Abrams and Fink (1972) also reported, in a preliminary fashion, that the incidence of prolonged organic confusional states seemed to be greater with multiple monitored than with comparable conventional ECT.

A variety of other related post-ECT phenomena have also been reported. Gottlieb and Wilson (1965) reported dysphasia in the form of mumbling and jargon speech especially after unilateral dominant ECT. Clyma (1975) reported finding similar dysphasis in his patients which typically resolved within 30 minutes of ECT. Annett, Hudson, and Turner (1974) also reported that dysphasia, as reflected in a naming task, was more pronounced after left than right unilateral ECT. In this same study, however, no difference between the modes of stimulation could be found in their effects on visual discrimination tasks.

There have been reports of transient neurological signs and symptoms occurring immediately after ECT (Kane, 1963; Kriss, Blumhardt, Halliday, & Pratt, 1978; Impastato & Karliner, 1966). These neurological findings have been mainly contralateral to the side of stimulation, transient with resolution within 20 minutes of treatment, and include decreased contralateral sensory discrimination, transient flaccid hemiparesis and even paralysis, asymmetric deep tendon reflexes, tactile and visual inattention (agnosognosia), and homonymous hemianopsia.

Early Psychometric Studies of Nonmemory-Associated Cognitive Effects of ECT

In the 1940s, in response to fears as to the potential for ECT to cause significant and perhaps even permanent brain damage, Perlson (1945) published a report of a male patient who had received 248 bilateral ECTs over a 2-year time span. When assessed with an extensive battery of tests following this 2-year period, he was found by the author to be of superior ability in comparison to the general population, to have "intellectual ability slightly better than expected for college level performance," and to have experienced no greater change in intellectual functioning than would have normally occurred as a consequence of 2 years of aging.

Stone (1947) reported generalized cognitive dysfunction, of which amnesia was only a part, occurring in association with from 4 to 20 ECTs. He noted that it progressively increased in severity with ECT from prior to the first treatment to from 24 to 30 hours after the last ECT and subsequently gradually diminished over the next 2 weeks. The kinds of post-ECT cognitive impairment he found included: decreased calculating ability, decreased auditory and reading comprehension, decreased ability to think abstractly and perceive interrelationships, decreased ability to make choices and clarify issues, and diminished ability to arrange words or objects according to a specified plan.

Luborsky (1948) found the effects of ECT on cognitive function to differ in schizophrenics and depressives. He gave each patient group a diverse battery of psychometric tests before ECT, after the 10th or 11th treatment, and 5 or 6 days after a completed series of 12 treatments. In the schizophrenics, he found impaired organizational-synthetic, visuomotor, and fluency of association functions after the 10th or 11th treatment in comparison to baseline, which he felt suggested the presence of organic brain dysfunction, but he could find little or no evidence of impair-

ment 5 to 6 days after the last ECT. His depressed patients showed a different pattern, with progressive improvement from baseline to posttreatment testing, without the initial impairment.

Huston and Strother (1948) administered the Babcock and Shipley-Hartford test batteries to depressed patients prior to ECT and 11 days and 6 months after the last treatment. The former battery includes 31 items that assess memory, attention, and psychomotor speed; the latter taps vocabulary and abstract thinking. At 11 days post-ECT, the results on the Babcock were slightly improved. At the 6-month posttreatment followup, statistically significant improvement had occurred with both.

Fisher (1949) demonstrated improvement in a variety of cognitive functions in depressed patients who had improved clinically with bilateral ECT, when pretreatment performance was compared with performance 14 days after treatment. He found significant changes in synthesizing ability, abstracting ability, speed of ideation, visuomotor ability, and estimation of self-performance.

Stone (1950) reported two patients who had received 14 and 20 ECTs, respectively, who manifested neither objective nor subjective diminution in performance on a battery of cognitive and intelligence tests from before to after ECT.

Pascal and Zeaman (1951) reported four patients in whom serial testing was done before, during, and after ECT with four different cognitive tests. These tests were: a noun-naming test, a color-naming test, the Bender-Gestalt, and a serial subtraction test. They found improvement in the tests early in the course of ECT followed by worsening as the course of treatment progressed with return to pretreatment baseline levels or better within several days of the last treatment.

Although their findings appear to be somewhat at variance with other reports in the the literature, Shapiro, Campbell, Harris, and Dewsberry (1958) reported that ECT did not cause an increase and, in fact, probably caused a relative decrease in psychomotor speed. Nor did it reduce the so-called "distraction effect" in which depressed patients doing a paper and pencil maze task speed up their performance when asked to count aloud at the same time.

More Recent Psychometric Studies of Nonmemory-Associated Cognitive Effects of ECT

McAndrew, Berkley, and Matthews (1967), on the basis of a battery of neuropsychological tests sensitive to specific right and left lateralized hemispheric functions as well as some sensitive to diffuse organic impairment without lateralization, given before and after six right or left unilateral or bilateral ECTs, found no statistically significant differences between or within groups. They did find an interesting trend for right unilateral ECT to lead to more frequent improvement on right than left hemisphere tests, for left unilateral to do just the reverse, and for bilateral to lead to identical percentages of improvement on both right and left hemisphere tests. The Halstead categories test, which is sensitive to diffuse cerebral dysfunction, showed identical percentages of improvement (75%) and worsening (25%) among the three treatment groups. In all three groups, after the sixth treatment there was evidence of some transient cerebral dysfunction. These findings suggest that, on the whole, ECT improves nonmemory cognitive function, though it may in some cases and at certain points in the treatment course induce variable degrees of transient diffuse cerebral dysfunction.

Small et al. (1972) tested ECT patients who had been randomly assigned to unilateral nondominant or unilateral dominant ECT with a battery of neuropsychological tests, modified from the Halstead-Reitan and Wechsler test batteries, before ECT, after five treatments, and 60 to 90 days after the last treatment. They found that after five unilateral nondominant treatments several Halstead-Reitan subtests (mainly right-sided) were improved. Five unilateral dominant ECTs did not result in Halstead-Reitan subtest improvement but did result in impaired Story Memory A performance. At followup 60 to 90 days later, the unilateral nondominant group showed sustained improvement, while the unilateral dominant group now had comparable improvement with clearing of the impairment in Story Memory A.

In a related study (Small et al., 1973), it was found that unilateral dominant, unilateral nondominant, and bilateral ECT were all associated with improvement in nonverbal, visuospatial,

nonmemory-related performance tasks and with temporary deterioration on tests requiring intact verbal function. Halstead-Reitan subtests that did change in this study were predominantly in the direction of improvement and were equally distributed among test items reflecting dominant, nondominant, and bilateral hemispheric function.

Reichert, Benjamin, Neufeldt, and Marjerrison (1976) reported that bilateral but not unilateral nondominant ECT produced impairments in "prograde effects" as reflected by decreased performance on the Quick Test, a test of general verbal cognitive processes and performance. These "prograde effects" included motivational, attentional, perceptual, and performance dimensions and therefore play an important role in facilitating information acquisition and storage, but not in mediating recall functions.

Kronfol et al. (1978) studied 18 depressed patients before and during ECT with a battery of neuropsychological tests capable of differentially assessing verbal and nonverbal cognitive functions. Prior to ECT, they found that 5 of the verbal and 13 of the nonverbal subtests were within the impaired range, and interpreted these findings as indicating that depression interferes with both verbal and nonverbal cognitive function but more so with respect to the latter. The posttreatment cognitive testing results, though actually involving relatively small and, for the most part, not statistically significant changes, was interpreted by the authors as indicating that left hemisphere functions declined following left-sided ECT while right hemispheric functions tended to improve after right-sided ECT. They noted disruption of both verbal and nonverbal cognitive tests after one unilateral dominant or nondominant ECT with the degree of verbal impairment being more significant. They interpreted the results obtained after the eighth ECT as reflecting the interaction of two factors, the disruptive effect of ECT in conjunction with the enhancing effect of relief from depression on cognitive processes. Their general conclusion was that ECT did not impair brain functioning but rather brought about significant improvement in nonmemory-related cognitive function as well as in depression.

Consistent with this is the finding of Miller et al. (1981) that the Halstead-Reitan impairment index and verbal, performance, and full-scale IQ scores obtained 2 weeks after a course of ECT are improved when they are compared to those obtained beforehand. As might be expected, the degree of improvement was greater with unilateral than bilateral ECT.

MacKenzie, Price, Tucker, and Culver (1982) compared the daily performance of patients receiving bilateral sinusoidal ECT with that of psychiatric inpatient controls not treated with ECT on a battery of four neuropsychological tests over the first 8 to 12 days of a course of bilateral ECT during which time a mean of 3.1 ECTs had been administered. Both groups improved on all the tests given, but the rate of improvement in the ECT patients was significantly less after three treatments had been given than that in the controls for the Letter Cancellation Test, though not for the others. On the basis of their findings, the authors suggested that some of the earliest effects of bifrontotemporal ECT may be impairment in attentional processes and the capacity to make appropriate shifts in behavioral set, functions thought to be mediated primarily by the frontal lobes (Mattes, 1980; Silverstein, Morrison, & Weinberg, 1980).

Goldstein et al. (1977) found on Halstead-Reitan testing in a small group of psychotically depressed patients evidence of diffuse, generalized, as well as localized right hemispheric dysfunction which was more prominent in patients with a prior history of ECT. There was neither systematic improvment nor worsening in the Halstead-Reitan battery after a course of either brief-pulse or sinusoidal ECT (it is unclear from the study whether the ECT was unilateral or bilateral). However, evidence of right hemisphere dysfunction had increased immediately after treatment and was even more pronounced at 3-month followup. The evidence of generalized, diffuse dysfunction was still present but decreased at 3 months post-ECT. A somewhat similar study done previously by Kendall, Mills, and Thale (1956) had also found no difference between pulse and sine wave stimulation in their effects on cognitive functions.

Horan, Ashton, and Minto (1980) studied depressed patients after three right unilateral ECTs with a battery of tests which tapped four general areas of cerebral functioning including verbal, memory, visuospatial, and visuomotor. The main findings were that the Knox Cube Im-

itation Test performance was improved, whereas other tests in the battery were not. The authors interpreted this finding as suggesting that the left hemisphere is specialized for processing sequential, time-dependent information. Further, they pointed out that unilateral ECT may be a powerful tool for investigating differential hemisphere functioning in cognitive areas other than memory, a research area that has been relatively little explored thus far.

Short- and Long-Term Followup Studies of the Effect of ECT on Nonmemory-Associated Cognitive Function

While relatively few studies have examined the long-term natural history of ECT-induced cognitive dysfunction, a variety of studies, some of which have been previously discussed, have examined the evolution of cognitive dysfunction over relatively short periods of time, i.e., 2 to 3 weeks at most, following ECT. The following are a few selected longer-term followup studies.

Goldman, Gomer, and Templer (1972) compared the results of Bender-Gestalt and Benton tests in 20 male schizophrenics who had received more than 50 ECT (50-219 with a median of 69.5) between 10 and 15 years previously, with matched schizophrenic controls without a history of ECT. They found a higher error rate in the ECT-treated patients and interpreted this as indicating organicity or permanent brain damage secondary to ECT. In view of the lack of control for severity of illness and the use of uncertain diagnostic criteria in this study, this conclusion must be viewed with caution.

Templer, Ruff, and Armstrong (1973) replicated the preceding study controlling for degree of psychosis and found that schizophrenics who had received more than 50 (median 58.5) ECTs at least 7 years before did not differ in WAIS and Benton scores but did have lower Bender-Gestalt scores than schizophrenic controls without a history of treatment with ECT. They interpreted their finding as being consistent with permanent brain dysfunction due to ECT.

Weeks, Freeman, and Kendell (1980) compared the results of a battery of 19 different memory and nonmemory tests administered to depressed patients before, 1 week, 4 months, and 7 months after unilateral nondominant or bilateral ECT to results obtained from non-ECT patient controls as well as normal controls. At 1 week posttreatment, ECT-treated patients did not perform worse on any of the cognitive tests and, in fact, improved significantly on several of them. At 4-month followup, the scores on cognitive tests in the ECT and non-ECT patient groups were virtually identical. At 7-month followup, the same was true except that there was a tendency for both patient groups to have slightly more impaired scores than the normal control groups. When the unilateral and bilateral ECT patients were compared, it was found that the former were significantly less impaired on cognitive testing than the latter at 1 week post-ECT and, in fact, were scoring close to the normal controls on many of the tests. However, at 4 months post-ECT there was no difference between the two ECT groups. The authors conclude that, in general, ECT does not cause lasting cognitive impairment and that with unilateral nondominant ECT there is very little impairment even in the short-term.

Freeman, Weeks, and Kendell (1980) reported that patients who had had ECT in the past, a mean of 10 years previously, and who still complained of cognitive dysfunction secondary to ECT, performed for the most part as well as normal controls on a variety of nonmemory cognitive tests. On the basis of these results, the authors concluded that ECT usually does not produce enduring ill effects on nonmemory-dependent cognitive function.

Summary

Based on this review, several conclusions emerge.

1. ECT causes immediate posttreatment confusion, which may be cumulative over a course of treatment; this posttreatment confusion is considerably less severe with unilateral than with bilateral treatment.
2. ECT does not cause lasting or permanent dysfunction in nonmemory-associated cognitive functions; though there may be initially or at some other point during the course of treatment, transient, reversible evidence of impairment.
3. If such transient impairments do occur, most studies suggest they will have cleared completely by between 2 and 8

weeks after the treatment course is completed.

4. A few studies raise the question of whether or not bilateral ECT may cause some long-lasting cognitive impairments in schizophrenic patients.
5. Overall, ECT improves nonmemory-associated cognitive functions compared to pretreatment baseline scores.
6. In general, effective treatment with ECT seems to improve nonmemory-associated cognitive dysfunctions associated with depression.
7. Unilateral nondominant ECT appears to improve specific right-sided neuropsychological dysfunction associated with depression, whereas unilateral dominant ECT may impair some left-sided neuropsychological funtion.
8. Acute organic mental syndromes are known to occur in up to 40-50% of patients receiving bilateral ECT; whether or not, and how frequently these may occur with unilateral nondominant treatment is not clear.
9. Certain drugs such as lithium and highly anticholinergic psychotropes such as amitriptyline or benztropine may, when given concurrently with ECT, increase the incidence of acute organic mental syndromes associated with it.

Questions for Future Research

Since the whole area of the effects of ECT on nonmemory-associated cognitive function is virtually in its infancy, a broad array of important research questions for the future exists. For example, will the fascinating early findings in regard to specific lateralized cognitive effects of right and left unilateral ECT hold up in future, well-controlled, prospective replicative studies? In this vein, will ECT turn out, as some suspect it may, to be a useful research tool in investigating the lateralization of cerebral hemispheric functions?

Could careful investigation of the relationship between stimulus and seizure variables and ECT-induced cognitive impairment allow for the development of treatment protocols which in terms of stimulus parameters and treatment schedules could optimize treatment efficacy while further minimizing the occurrence, however transient, of cognitive disturbances? Specifically, if, as seems possible, changes in attentional function are among the earliest to occur after bilateral ECT and if, as also seems possible, they occur early on a continuum with more diffuse and flagrant later organic mental symptoms, might it be possible by monitoring them to identify patients at high risk of developing acute organic mental syndrome and, on the basis of these findings, appropriately adjust the number, type, and/or frequency of treatments given.

Will careful future investigation of the beneficial effects of ECT on certain specific cognitive dysfunctions in depression perhaps shed further light on their etiology or perhaps on the basis for some of the therapeutic effects of ECT?

Other important questions include the following. How frequently do acute organic mental syndromes occur after unilateral nondominant ECT and how might their clinical manifestations differ from those that occur after bilateral ECT? If interference with frontal lobe attentional mechanisms is the basis for at least some portion of the post-ECT acute organic mental syndrome, might there perhaps be some pharmacological means of preventing this, such as with Ritalin or Pemoline?

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Nonmemory Higher Cognitive Function and Electroconvulsive Treatment

Sheri A. Berenbaum, Ph.D.,[1] and Michael Alan Taylor, M.D.[1]

The short-term effects of electroconvulsive therapy (ECT) upon mnestic function are well known. Bilateral ECT results in both retrograde and anterograde amnesia, with both verbal and nonverbal memory adversely affected. The effect is significantly smaller but not insubstantial following unilateral ECT. The degree of deficit is

[1]Departments of Psychology, and Psychiatry and Behavioral Sciences, University of Health Sciences/The Chicago Medical School, North Chicago, IL 60064.