ELECTROCONVULSIVE THERAPY

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impairment reported for nonelectrical methods of induction—pentylenetetrazol and flurothyl (Fink, 1979)—and by the extensive literature demonstrating that the amnesic effects of bilateral ECT can be sharply reduced simply by repositioning the treatment electrodes over the right hemisphere, an effect that is independent of stimulus dose (Weiner et al., 1986b; Squire and Zouzounis, 1986).

These data suggest to me that when markedly suprathreshold electric currents traverse the temporal lobes and diencephalon—as with bilateral ECT (Weaver et al., 1976)—the electrical stimulus is then anatomically well-positioned to impair memory functions, which it does in relation to its intensity and to a much greater extent than the seizure that it induces. With reduced dosage, or diversion of the electrical stimulus from the structures subserving memory, however—as in low-dose bilateral ECT, unilateral ECT, or anterior bifrontal ECT—the cognitive impact of the stimulus relative to the seizure is markedly reduced, and the seizure then assumes preeminence. (This argument is analagous to that previously presented concerning the relative therapeutic effects of stimulus and seizure.)

Just as no monolithic entity "ECT" was valid for the discussion of therapeutic efficacy, so arguments on the nature of ECT-induced disorientation, dysmnesia, and impaired cognition are contingent on knowledge of stimulus type, dosage, and application site. Thus, for markedly suprathreshold sine-wave, bilateral ECT, Ottosson's (1960) dictum can be taken as proved: Memory impairment is primarily a function of the electrical stimulus, and depends to a much lesser extent—if at all—on seizure duration. For right unilateral ECT, however—whether sine-wave or brief-pulse—disorientation and memory impairment appear to be more a function of seizure duration than electrical dosage.

Confusion

Although the imprecise term confusion as generally applied to ECT subsumes mainly disorientation, a patient recovering consciousness after ECT might understandably exhibit multiform abnormalities of all aspects of thinking, feeling, and behaving, including disturbed memory, impaired comprehension, automatic movements, a dazed facial expression, and motor restlessness. The term disorientation is also misleading because its "time, place, and person" components are actually memories, some recent (e.g., age and date) and some remote (e.g., name). True orientation, that is, the ability properly to locate one's self in space and time solely by environmental cues, has not been studied with regard to ECT.

Lunn and Trolle (1949) studied 21 patients during a 2-hour, post-ECT period at intervals of 10, 30, 60, and 120 minutes. Personal orientation items of name and marital state were most resistant to the effects of ECT. At the 10-minute assessment interval 90% of the patients could give their name, whereas only 10% could give their age. This finding nicely demonstrates a temporal gradient of retrograde amnesia because a lifetime elapses between the learning of these two variables. Improvement in all functional areas was rapid but only reached 100% accuracy by the end of the 2-hour interval for items testing agnosia, visual perception, and apraxia. At the same test interval, five items of time orientation were responded to with less than 60% accuracy. The observation by Daniel and Crovitz (1986) of a close correspondence between the curves for postical recovery of these orientation items and the temporal resolution of retrograde amnesia reported by Cronholm and Lagergren (1959) are consistent with the view that conventional tests of orientation simply measure memory.

Wilcox (1955) administered various tests of intellectual functioning at 15, 30, and 45 minutes post-ECT in 51 patients and confirmed Lunn and Trolle's (1949) results, reporting that memory for name was present in 97% of the observations made immediately on awakening, but that memory for time was often still impaired when tested 45 minutes later. Mowbray (1959) studied the recovery of consciousness after ECT in 30 patients by a method of continuous systematic interrogation from the period of postictal stupor to the re-establishment of full consciousness. Again, memory for name was present almost immediately, followed in short order by address, marital status, and birthplace, whereas memory for age, year, and date was not restored until an average elapsed time of slightly more than 45 minutes. Similar results were obtained by later investigators (Lancaster et al., 1958; Daniel and Crovitz, 1986; Daniel et al., 1987; Calev et al., 1991b).

Moreover, Daniel et al. (1987) observed that during the postictal period following ECT, patients gave responses to age and current year that were displaced backward in time, supporting the notion that such disorientation represents retrograde amnesia. With postictal clearing, however, the backward displacement became compressed, similar to the shrinking of the retrograde amnesia observed following

head-injury and consistent with the widely-reported temporal gradient of retrograde amnesia.

The temporal gradient for memories affected during the postictal recovery period was demonstrated in a different way by Rochford and Williams (1962), who asked patients emerging from ECT to name a series of simple common objects, the names of which are acquired at different ages in childhood. Whereas *comb* (a word usually learned by 4 years of age) could be named by about 90% of patients shortly after being able to give their own names, the *teeth* of the comb (not learned until about 11 years of age) could not be named until 12 minutes later.

Relation to Treatment Electrode Placement

Early workers were unanimous in describing less postictal confusion after unilateral than after bilateral ECT (Goldman, 1949; Bayles et al., 1950; Blaurock et al., 1950; Impastato and Pacella, 1952; Liberson, 1953; Liberson et al., 1956; Thenon, 1956; Lancaster et al., 1958; Cannicott, 1962; Impastato and Karliner, 1966), although their reports can be faulted for lack of a systematic methodology and for confounding the effects of electrode placement with stimulus type (usually brief-pulse). Numerous subsequent investigators have used the time required for the postictal return of full orientation to measure more precisely the confusion induced by different treatment techniques (Gottlieb and Wilson, 1965; Valentine et al., 1968; Halliday et al., 1968; Sutherland et al., 1969; d'Elia, 1970; Fraser and Glass, 1980; Daniel and Crovitz, 1986). With the exception of the study of Gottlieb and Wilson (1965), the results confirm the earlier observations that reorientation occurs more rapidly after right unilateral ECT than after bilateral ECT. Moreover, investigators who included a left unilateral ECT group for comparison reported that this method, along with bilateral ECT, was associated with slower reorientation or more postictal confusion than right unilateral ECT (Halliday et al., 1968; Sutherland et al., 1969; Cronin et al., 1970; d'Elia, 1970). A similar advantage for right unilateral ECT is obtained when patients emerging from ECT are required to recall words or sentences learned shortly before the seizure (Lancaster et al., 1958; Cannicott and Waggoner, 1967; Valentine et al., 1968).

More recently, Sackeim et al. (1986b) studied time to reorientation in a sample of depressives receiving brief-pulse, right unilateral or bilateral ECT with stimulus charge titrated to just-above threshold