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Brief Report

Autobiographical Ammesia with ECT: An Analysis of the Roles of Stimulus Wave Form, Electrode Placement, Stimulus Energy, and Seizure Length

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INTRODUCTION

Based on the hypothesis that decreased stimulus energy might reduce ECT-induced amnesia, Liberson (1948) and others advocated seizure induction with low-energy pulse wave forms instead of the conventional sinusoidal wave form. Recent studies have reported similar antidepressive efficacy between brief-pulse and sinusoidal ECT (Carney and Sheffield, 1974; Weaver *et al.*, 1977; Welch *et al.*, 1982). However, existing studies (Medlicott, 1948; Epstein and Wender, 1956; Kendall *et al.*, 1956; Valentine *et al.*, 1968) that report more amnesia following sine than pulse ECT contain methodological inadequacies that render the results equivocal (discussed by Daniel *et al.*, 1982; Daniel and Crovitz, in press).

Preliminary results from a recent study (Weiner *et al.*, 1982) revealed a nonsignificant trend towards greater "personal memory" impairment following sinusoidal than brief-pulse ECT. Another recent study (Daniel *et al.*, 1982) reported no intergroup difference in *autobiographical memory* (memory for a specific episode in patients' lives). However, this latter study used a *single*

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question to assess autobiographical memory. Ceiling and floor effects could therefore have obscured an intergroup amnestic difference. Furthermore, responses to this question were not objectively verifiable. These deficiencies were overcome in the present study by using four questions, two of which were objectively verifiable.

MATERIAL AND METHODS

Subjects and ECT Technique

Twenty-two male depressed inpatients were studied. Criteria for selecting these patients were identical to those used in our earlier investigation (Daniel *et al.*, 1982). Patients received either *bilateral* frontotemporal ECT or *unilateral nondominant* ECT (d'Elia, 1970, placement). Electrical stimulation was either bidirectional *brief-pulse* (800 mA peak amplitude, 60-70 pulse-pairs/sec, 0.75-1.5 msec pulse width, 1.0-2.0 sec duration; MECTA Corp. Device) or bidirectional *sinusoidal* (140-170 V rms, 60 Hz, 0.4-1.0 sec duration; Medcraft B-24 Mark III device). Thus four treatment groups were formed (unilateral nondominant pulse, unilateral nondominant sine, bilateral pulse, bilateral sine). Patients were randomly assigned to these groups.

Detailed information concerning treatment spacing, premedication, anesthesia, muscle relaxation, and usage of oxygenation can be found elsewhere (Daniel *et al.*, 1982). Duration of epileptiform EEG activity was measured with a single EEG channel. Symmetry of seizures was determined by gross observation of tonic-clonic movements. No asymmetries were noted. The total number of joules of electrical energy was measured with a custom-made watt-second meter (Indiana University). Table I illustrates patient and ECT variables.

Table I. Patient and ECT Variables

Variable	Mean	Standard deviation
Age (years)	58.5	10.9
Base-line Hamilton score	44.1	11.2
Education (years)	11.0	2.4
Base-line Shipley IQ	94.0	13.5
Atropine (mg)	0.8	0.2
Methohexital (mg)	66.8	12.1
Succinylcholine (mg)	79.5	23.0
Seizure length (sec)	55.3	36.5
Electrical energy		
Sine ECT	62.2	31.3
Pulse ECT	24.4	13.8
All patients	45.0	31.1

The four ECT groups were balanced with respect to all of these variables except electrical energy. Sinusoidal stimulation delivered more joules of electrical energy than did pulse stimulation ($F = 14.5$, df = 1, 18 $p < 0.002$), a difference which is consistent with that reported elsewhere (Weaver *et al.*, 1977; Weiner, 1980; Daniel *et al.*, 1982).

Memory Testing

Thirty minutes before their fifth ECT, each patient was asked to find a hidden figure of a cow in a photograph (see Dallenbach, 1951; Crovitz *et al.*, 1981) by one of two randomly selected examiners (mean perceptual time: 170 sec).

Twenty-four hours after ECT, the patient was approached by two examiners, one of whom had shown him the cow photograph the previous day. One examiner, who did all of the autobiographical memory questioning (randomly determined), asked the patient (1) "Do you remember being shown a black-and-white photograph yesterday morning before your treatment?" The patient was then shown four hidden figure photographs (see Crovitz *et al.*, 1981), including the cow photograph, one at a time (randomized order). The patient was then shown all four photographs simultaneously and was asked (2) "Which of these four photographs did you see before your treatment yesterday?" This question enabled us to objectively verify presence or absence of autobiographical memory. The patient was informed that he was shown the cow photograph before his treatment, and was asked (3) "Do you have any memory now of having seen the cow picture before your last treatment?" This question was asked to see if autobiographical memory was reinstated by the repeated exposure to the cow photograph (Janis, 1950; Schacter and Tulving, 1982). The patient was then asked (4) "Which one of us showed you the cow figure before your last treatment?" This procedure allowed us to further objectively verify the presence or absence of autobiographical memory by randomly varying the examiner before and after ECT, and using the examiner as a multiple-choice recognition stimulus after ECT.

RESULTS

Responses to the four questions were combined to form a single autobiographical memory score for each patient. An analysis of covariance (Hays, 1973), controlling for joules of electrical energy and seconds of seizure activity, revealed that there were significant main effects for *both* electrode placement ($F = 14.7$, df = 1, 17, $p < 0.002$) and stimulus wave form ($F = 5.4$, df = 1, 17, $p < 0.04$), with bilateral and sinusoidal ECT producing greater autobiographical memory impairment than unilateral nondominant and brief-pulse ECT, respec-

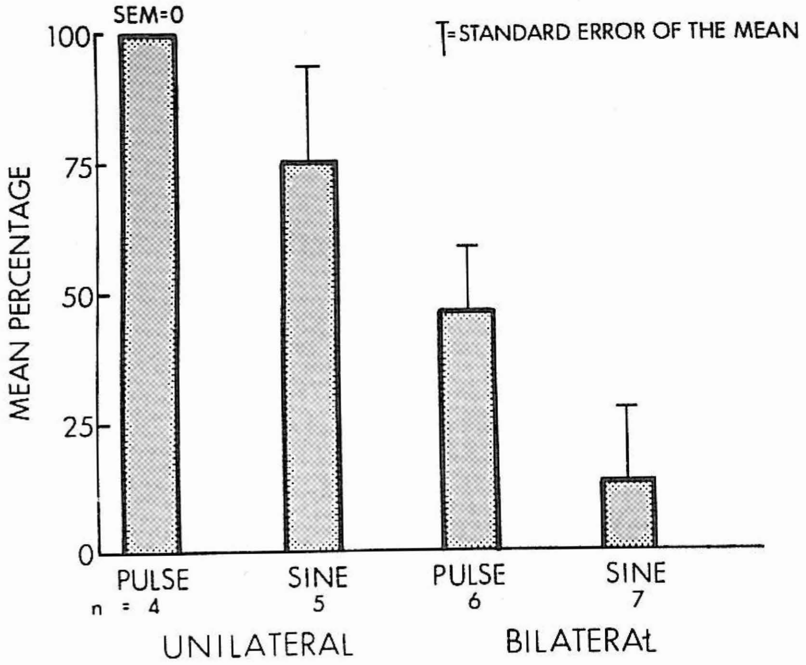

Fig. 1. Intergroup differences in autobiographical memory. Scores are percentage correct of the four questions.

tively (see Fig. 1). No significant effects of electrical energy ($F = 0.5$, df = 1, 17, $p > 0.50$) or seizure length ($F = 0.8$, df = 1, 17, $p > 0.30$) upon autobiographical memory were found.

DISCUSSION

Our results indicate that autobiographical memory for a specific episode in a patient's life tended to be a fragile entity that was sensitive to variations in ECT technique. Our earlier study (Daniel *et al.*, 1982) did not find an effect of stimulus wave form on autobiographical memory, whereas the present investigation did. This difference is probably related to the more thorough and sensitive evaluation of autobiographical memory in the present investigation, with two questions being objectively verifiable. For example, the one patient who said "no" to the first question and "yes" to the third question picked the wrong examiner when asked question number 4.

The finding of more autobiographical amnesia following bilateral than unilateral nondominant ECT is consistent with other reports of greater retrograde

amnesia following bilateral than unilateral nondominant ECT (e.g., Costello *et al.*, 1970; d'Elia, 1970; Daniel *et al.*, 1982). This is the first investigation, however, to statistically demonstrate greater amnesia following sinusoidal than brief-pulse ECT without differences between the two treatments in electrode placement, oxygenation, treatment number, spacing of treatments, or postictal confusion (see Daniel *et al.*, 1982; Daniel and Crovitz, in press). The reason for this amnestic difference is unclear.

Although sinusoidal ECT delivered more joules of electrical energy than did brief-pulse ECT ($p < 0.002$), autobiographical memory scores were not affected by the amount of electrical energy received ($p > 0.50$). Furthermore, controlling for electrical energy did not eliminate the statistically significant amnestic difference between sinusoidal and brief-pulse ECT. It is therefore unlikely that the intergroup amnestic difference was the result of a difference in electrical energy *per se*.

Another source of the intergroup amnestic difference is a difference in seizures. Some investigators report that incompletely generalized seizures have occurred during low-energy brief-pulse ECT (Gayle and Josephs, 1948; Liberson, 1948, 1953; Goldman, 1949; Cronholm and Ottosson, 1963). Sinusoidal ECT may produce more highly generalized seizures than pulse ECT (Docter, 1957; Fink, 1979). Weiner *et al.* (1982) recently reported more EEG slowing following sinusoidal than brief-pulse ECT, a result which is consistent with this hypothesis, since more EEG slowing should follow more completely generalized seizures. In the present investigation, more autobiographical amnesia may have followed sinusoidal than brief-pulse ECT because more completely generalized seizures may have occurred with the former than the latter treatment modality. It appears warranted to suggest that the interrelationships among memory, degree of seizure generalization (utilizing multichannel EEG indices of seizure activity), and stimulus wave form be examined in future investigations.

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Brief Report

Stimulation of the Paleocerebellar Cortex of the Cat: Increased Rate of Synthesis and Release of Catecholamines at Limbic Sites

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Evidence from neuroanatomic, electrophysiologic, biochemical, and behavioral studies has established that the anterior vermal cortex, acting primarily through the fastigial nuclei, can modulate the activity of key limbic nuclei involved in emotional expression (Ball *et al.,* 1974; Paul *et al.,* 1973; Heath and Harper, 1974, Heath, 1975, 1977; Heath *et al.,* 1978, 1980; Maiti and Snider, 1975; Snider and Snider, 1977; Cano *et al.,* 1980). Since the fastigial nuclei have been shown to connect with brain stem and mesencephalic catecholaminergic neuronal groups, which are known themselves to project widely to limbic areas, at least part of the paleocerebellar influence on emotion is thought to arise from altered limbic catecholamine levels (Assaf and Miller, 1977, Beckstead *et al.,* 1979; Koob *et al.,* 1975 Snider, 1975; Snider *et al.,* 1976; Scatton *et al.,* 1980; Segal and Bloom, 1974; Simon *et al.,* 1979). Classic long-term studies following various cerebellar lesions have, indeed, shown catecholamine changes in limbic areas (Snider and Snider, 1977; Cano *et al.,* 1980). The development of the push-pull cannula technique now permits short-term observations on altered catecholaminergic mechanisms (Nieoullon *et al.,* 1978). This brief report describes some initial promising findings on acute increases in catecholamine synthesis and release at catecholaminergic terminals using the push-pull technique in cat limbic lobe under vermal stimulation.

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