Since the inception of the use of artificially induced convulsions as a therapeutic agent in 1935 by Meduna and the modification of this method of treatment by the use of electric currents by Cerletti and Bini in 1938, a vast literature has accumulated on this form of psychiatric treatment. Yet, despite this vast literature and the passage of over 30 years of experimental opportunity, no predominant or convincing rationale for the use of electroconvulsive therapy (E.C.T.) has emerged; Meduna’s (53) original theory of the incomparability of schizophrenia and epilepsy having been long discredited. E.C.T. remains, therefore, an empirical form of treatment.

The immediate effect of E.C.T. is most noticeable at a physiological level, but it is usually prescribed for its alleged psychological effect on affective symptoms; and hence, in trying to explain the effects of E.C.T., both physiological and psychological theories will be of interest. However, it is the purpose of the present paper to review only psychological theories of E.C.T.

Theoretical approaches towards explaining the effects of electroconvulsive shock (E.C.S.) on animals will also be considered. As the work on E.C.S. with animals has been more empirical than corresponding work with humans, it has led to more consistent findings and a sounder basis for theorizing. Hence, theories drawn from animal research may be able to give useful leads for explaining the effects of E.C.T. on humans.

What Needs to be Explained?

Before considering theories in detail it is necessary to be clear about what phenomena are to be explained. Therefore, the main and the best established phenomena will be briefly treated below.

(i) The Therapeutic Efficacy of E.C.T.

Although most theories of E.C.T. assume a beneficial therapeutic effect, the evidence for this from well-controlled studies is somewhat equivocal (65). However, at least two controlled studies (44, 68) have indicated that depressed patients treated by E.C.T. have a better clinical outcome than those not so treated. Campbell (12) draws attention to the idea that E.C.T. may be effective in speeding up recovery that is underway rather than by actually causing recovery. There is evidence in favour of this (24) and Slater’s (69) reassessment of Karagulla’s (42) data is also consistent with this idea.

A large number of studies agree that recovery following E.C.T. is better for affective disorders, especially depression, than for other disorders. Similarly, some recent research (13, 54, 66) has confirmed the common clinical impression that recovery rates are better for endogenous than for exogenous depressions. However, studies comparing the response to treatment of different diagnostic groups have generally not controlled for differences in untreated remission rates.

It seems reasonable to conclude that, compared with most other psychiatric treatments, the therapeutic efficacy of E.C.T. is reasonably well established. Even if Riddell’s (65) conclusion that an unequivocal proof is lacking is accepted, there is at least a strong indication that E.C.T. is more effective than no treatment at all, especially in cases of endogenous depression.

(ii) Memory Disturbances

Almost all authorities who have considered this problem agree that E.C.T. causes a degree of memory loss for events preceding the treatment. Experimental verification of this has been provided (10, 39), and Cronholm and his associates have made an attempt to explore the parameters of this effect (19, 20, 21).
(iii) Confusion

A large number of authors, especially those advocating the intensive use of E.C.T., report that E.C.T. produces confusion, the extent of which seems to depend on the number and frequency of the treatments \(10, 30, 43, 72\). Paradoxically, besides itself producing confusion, E.C.T. is used effectively in certain conditions, such as severe manic excitement, in which confusion is present as part of the clinical picture. In these latter conditions E.C.T. appears to clear up confusion rather than cause it, but this may well be because the E.C.T. acts upon the cause of the original confusion thus reducing it to a greater extent than any added confusion due to the E.C.T.

(iv) Other Psychological Effects

Investigations of the effects of E.C.T. on a large number of psychological tests, on motor speed and on perception, have also been carried out but the results are often contradictory and do not lead to clear cut conclusions. The important effects of E.C.T. appear to be the first three given above.

A point also worth noting here is the fact that in all forms of convulsive therapy it is the convulsion itself which seems to be the effective agent in all forms of convulsive therapy. It is reasonable to apply theories originally designed to account for the effects of drug-induced convulsions to E.C.T. also.

Among this group of theorists, all agree, either explicitly or implicitly, that E.C.T. has mental effects by assisting the process of repression, which is hence opposed to psychoanalysis, which is engaged at recovering repressed material \(70\). Also, it goes further than any other theorist with the concept of repression in that he uses it to account not only for the beneficial effects of E.C.T. but also for the amnesia and other negative sequelae of treatment. He claims that these effects are just what he would predict on the basis of such repression having taken place.

The various psychoanalytic theories differ from the hypotheses put forward concerning the exact mechanisms which either cause or accompany repressive mechanisms. The three most common theories of repression are discussed below and have been most used in varying permutations and combinations by the different theorists.

The Regression Hypothesis:

A number of authors \(2, 3, 31, 58, 62\) have regarded the treatment as producing regression of behaviour to infantile, or even pre-natal, levels. Usually the regression is thought of as being psychologically induced by the stress involved in the treatment situation, though Power \(62\) feels that the regression is physically induced by the convulsion. Power argues that since the tonic and clonic phases of the convulsion are similar to movements seen in the foetal stage of both man and sheep, and that these phases do represent a return to a foetal level of nervous functioning. Others, holding that the regression is psychologically induced, relate post-convulsive behaviour, such as apparent sucking, movements or faecal smearing, to the Freudian concept of the instincts of psychosexual development \(31, 58, 73\). This position is strengthened by the observation of patients following E.C.T. during a regression.
ch seems to be the effect of convulsive therapy as described by child psychologists such as Piaget or Gesell. One basic difficulty with this hypothesis is that it is difficult to test convincingly, as it is always possible for those predisposed to interpret regression as the standard procedure. Neither indifference nor guilt are the effective element in the treatment of endogenous depressives, who often show strong guilt feelings, respond most favourably to E.C.T. Other aspects of the hypothesis are less satisfactory. It assumes that the patient identifies the doctor with his parent. This, in turn, implies a regression to childhood, at least to a stage at which the child is dependent on parental sanctions and discipline.

There has been no direct test of this hypothesis, although Lockwood (49) has tested a derivation of it based upon Rosenzweig's (67) classification of responses to frustration. Lockwood argued that introjective subjects should show the best response to E.C.T., but failed to reveal infantile speech or behaviour in the therapy that this has been described by child psychologists such as Piaget or Gesell. One basic difficulty with this hypothesis is that it is difficult to test convincingly, as it is always possible for those predisposed to interpret regression as the standard procedure. Neither indifference nor guilt are the effective element in the treatment of endogenous depressives, who often show strong guilt feelings, respond most favourably to E.C.T. Other aspects of the hypothesis are less satisfactory. It assumes that the patient identifies the doctor with his parent. This, in turn, implies a regression to childhood, at least to a stage at which the child is dependent on parental sanctions and discipline.

There has been no direct test of this hypothesis, although Lockwood (49) has tested a derivation of it based upon Rosenzweig's (67) classification of responses to frustration. Lockwood argued that introjective subjects should show the best response to E.C.T., but failed to reveal infantile speech or behaviour in the therapy that this has been described by child psychologists such as Piaget or Gesell. One basic difficulty with this hypothesis is that it is difficult to test convincingly, as it is always possible for those predisposed to interpret regression as the standard procedure. Neither indifference nor guilt are the effective element in the treatment of endogenous depressives, who often show strong guilt feelings, respond most favourably to E.C.T. Other aspects of the hypothesis are less satisfactory. It assumes that the patient identifies the doctor with his parent. This, in turn, implies a regression to childhood, at least to a stage at which the child is dependent on parental sanctions and discipline.

 There has been no direct test of this hypothesis, although Lockwood (49) has tested a derivation of it based upon Rosenzweig's (67) classification of responses to frustration. Lockwood argued that introjective subjects should show the best response to E.C.T., but failed to reveal infantile speech or behaviour in the therapy that this has been described by child psychologists such as Piaget or Gesell. One basic difficulty with this hypothesis is that it is difficult to test convincingly, as it is always possible for those predisposed to interpret regression as the standard procedure. Neither indifference nor guilt are the effective element in the treatment of endogenous depressives, who often show strong guilt feelings, respond most favourably to E.C.T. Other aspects of the hypothesis are less satisfactory. It assumes that the patient identifies the doctor with his parent. This, in turn, implies a regression to childhood, at least to a stage at which the child is dependent on parental sanctions and discipline.

There has been no direct test of this hypothesis, although Lockwood (49) has tested a derivation of it based upon Rosenzweig's (67) classification of responses to frustration. Lockwood argued that introjective subjects should show the best response to E.C.T., but failed to
confirm this in two separate experiments. However, this is not a crucial test, as the punishment hypothesis could be valid without Lockwood's extension of it being valid also. The punishment hypothesis remains, therefore, non-proven.

Summary of Psychoanalytic Theories

The general criticism can be made of nearly all psychoanalytic theories that they rely heavily on factors in the treatment situation other than the convulsion itself (e.g. the patients' fear of treatment), thus ignoring the consistent finding that the convulsion is the effective agent in treatment. In addition they rely on a background theory which is in itself unproven. Psychoanalysis seems, therefore, not to be a fruitful starting point for an explanation of the effects of E.C.T.

(b) Non-Psychoanalytic Theories

Somatic Theories

There are a large number of somatic theories. All have in common the obvious inference that if some fairly permanent behavioural change occurs in the patient as a result of treatment, such a change must be correlated with some somatic change within the nervous system. A large number of suggestions have been made as to the change that occurs (26), but these generally lie outside the scope of this review.

Psychological research has been attracted towards one particular type of somatic theory which assumes that E.C.T. has its effects by damaging nerve cells (29, 73). One group of experimenters (71) found that their subjects, after three E.C.T.'s, showed a definite change in Rorschach responses towards the pattern of responses produced by patients with diffuse brain damage. Others have found that short-term response to treatment is correlated with positive results on the amylobarbitone test for brain damage (41).

The worth of such findings, and of findings from similar experiments, is strongly jeopardized by the general unreliability of such indices of brain damage. A more direct approach is obviously to be preferred, and there is some evidence of vascular changes, probably temporary, in both human and animal brains after E.C.T. (34, 59).

The evidence is consistent with the possibility of a small degree of diffuse brain damage being caused by E.C.T. Unfortunately this still leaves the structural theory unproven, as it is necessary to demonstrate that the damage involved is the main agent of behavioural change and is merely an incidental feature of the treatment.

Theories Involving Amnesia

These predominantly centre around the suggestion that the treatment-induced amnesia might be responsible for the beneficial effects (11, 40, 59). It is often pointed out that amnesia is usually greatest for experiences which come immediately before treatment, and that these and other psychotic episodes, being usually recent, are more likely to be affected by amnesia than more normal experiences from the subject's distant past. Janis (40) also feels that the amnesic action of E.C.T. becomes a new learned defence mechanism enabling the subject similarly banish stressful experiences occurring subsequent to treatment.

The amnesic effect of E.C.T. is the apparent rationale for treatment by "regressive" E.C.T. (30, 43) or "depatternning" as it is called by Cameron (11). The general principle of regressive E.C.T. is the intensive use of E.C.T. at rates of one or more treatments per day until the patient is in a totally amnesic state, and confused and often doubly incontinent. As the patient recovers, he learns, or is taught, new and better adjusted patterns of behaviour. Several authors have enthusiastically reported the results of this form of treatment on chronic patients, but there has been no attempt at controlled study. There is only one report of the use of regressive E.C.T. that has come to the conclusion that it is of no value (73).

A variation of this theory is the suggestion that there is a differential loss of material relating to the patients' psychopathology (11, 40). Cameron (11) suggests that as the amnesia following intensive treatment recedes, these further events are recalled to the extent that they are compatible with the emerging framework of the patients' behaviour. If the patients...
an and animal brains are not consistent with the possibility that diffuse brain damage below the critical level observed in human patients will lead to characteristic changes in behaviour. Unfortunately, this has not been demonstrated in patients. However, it is possible that the changes observed in patients are due to the development of a new pattern of behaviour. Unfortunately, there have been no reports of the development of a new pattern of behaviour in patients with brain damage.

nnesia

Events related to previous abnormal behaviour will be incompatible and hence not accessible. The treated patients showed amnesia which was more apparent both for the recent material and for anxiety provoking material. However, an adequate test of the hypothesis of differential action of the amnesic and pharmacological agents used in the treatment is almost impossible because of the difficulty of controlling for the degree of learning of both normal and pathologically altered material.

Direct experimental investigations of the role of amnesia in the therapeutic effects of E.C.T. are not available. Information of some relevance comes from work with unilateral E.C.T. (47, 52), where the general finding is that unilateral E.C.T. can be as therapeutically effective as bilateral E.C.T., but gives significantly less brain damage. This suggests that the amnesic effect of E.C.T. does not depend on amnesia, but it is a possibility that even the side treated cases had some degree of amnesia which was adequate for therapeutic efficacy. No untreated controls were used to test for this.

The evidence from unilateral E.C.T. points to the general principle that the intensive use of E.C.T. in one hemisphere may enable the subject to access material that is inaccessible to the other hemisphere. E.C.T. based on amnesia. A direct experimental test of this theory would be useful.

Neural Consolidation Theory

This is the most prominent theory in E.C.T. research with animals, and often other theories in this field were inspired by alleged inadequacies in this theory. Briefly, the theory assumes that for any memory to become established it is necessary for the original memory traces, which are only temporary in form, to be transferred to a more permanent form, i.e. consolidated. An E.C.T. occurring within the time period that consolidation is taking place will break up the process of consolidation, causing R.A. for material not already consolidated.

Early experiments (25, 74) showed retention to be a negatively accelerated function of the
interval between learning and E.C.S. and were generally accepted as demonstrating the validity of this theory. More recently these early experiments have been criticized, as they used several learning trials, thus giving the early trials time to consolidate before the later trials came along (61). More satisfactory experiments using one learning trial followed quickly by a single E.C.S. (45, 51) have, however, upheld the consolidation theory. Other experiments using the same initial design but going on to give further learning trials and E.C.S.s have concluded that other factors come into operation when several E.C.S.s are given (15, 38). Chevalier (14), again using a one learning trial and single E.C.S. design, has shown that the R.A. effect remains undiminished over 30 days.

Lewis and Maher (48) have brought together a number of results inexplicable by the consolidation theory. One experiment (3) has shown that a series of E.C.S.s given a few days prior to learning have a proactive effect. Others (9) have shown that a series of E.C.S.s given a few days after learning, and hence long after what would generally be considered as the consolidation period, can also disrupt retention. Brady (8) also found that when a learned response was obliterated by a series of E.C.S.s given some time after learning, there was some degree of recovery of the response 90 days after the last E.C.S. As the breaking up of consolidation should give a permanent loss, this last result is also inexplicable by the consolidation theory.

The consolidation theory has been universally upheld by experiments using the one learning trial followed by a single E.C.S. paradigm. However, other experiments give results unaccountable for by this theory. It is of importance from the point of view of subsequent discussion to note that in the latter group of experiments a series of E.C.S.s has always been used; no one has yet demonstrated proactive or retroactive effects after a long delay from a single E.C.S.

Conflict Theory

This is analogous to the fear theory of the psychoanalysts for E.C.T. It suggests that E.C.S. has its effect by being an aversive or fear-provoking stimulus. Coons and Miller (13) in an experiment replicating some features of an earlier experiment by Duncan (25) obtained results which they interpreted as showing the fear was induced by E.C.S. Unfortunately, the experiment failed to control for the effect of E.C.S. alone, and so the effect of E.C.S. was confused with other variables (37).

Experiments using one aversive learning trial quickly followed by a single E.C.S., in a direct test of this theory, have shown that the apparent effect of E.C.S. is stronger than any induced fear (45, 51). However, other experiments have found that after a series of E.C.S.s has been given apparently aversive effects of E.C.S. do appear (15, 25).

As the conflict theory cannot account for the results of experiments using the one learning trial and single E.C.S. paradigm, it cannot be used to displace the consolidation theory. Experiments giving several E.C.S.s have found effects attributable to fear but which could be explained in other ways. It would seem reasonable to suppose that undergoing a series of E.C.S.s is an “unpleasant” experience for a rat; the problem is whether any fear occurring is of significance in explaining the effects of E.C.S.

Competing Response Theory

This theory, originally proposed by Adams and Lewis (5) to account for an apparent deficiency in the consolidation theory, assumes that some aspect of the response to the E.C.S. becomes conditioned to stimuli in the surroundings. The most recent statement of the theory is by Lewis and Maher (48), who suggest that the coma following the seizure is due to “protective inhibition” and that components of the inhibition become conditioned to surrounding stimuli in the experimental apparatus.

If this theory is correct, it would be predicted that E.C.S. given in the same location as learning took place would disrupt learning much more than when given in a dissimilar situation. The original proposers (6) tested this and obtained confirmatory results, but in a similar experiment Quatermain et al. (64) found that the location in which E.C.S. was given was
The reasons for failure appear, basically, to be threefold. Firstly, knowledge of the aetiology of illnesses treated by E.C.T. is minimal. If it were possible to reliably implicate a process or processes, of whatever nature, as being the cause of endogenous depression, then this would give an excellent lead to investigations and theorizing. Secondly, whether it is possible to suggest ways for a more successful theoretical approach.

Why Have Theoretical Attempts Failed?

The difficulties in postulating a state of confusion in animals receiving massed E.C.S.s are twofold. Firstly, such a concept as clouding of consciousness, which is part of the general psychiatric description of confusion, is almost meaningless when applied to animals. However, it would be possible to define confusion in animals operationally in terms of other features of confusion, such as spatial disorientation or possibly impairment of attention. Secondly, it is not yet possible, on the evidence available, to completely eliminate the conflict or competing response theories as explanations of the effects of massed E.C.S.s, but experiments could be designed to test these theories against the hypothesis of confusion.

**DISCUSSION**

In 1948 Gordon was able to write a paper entitled "Fifty shock therapy theories" (32). Since then, theories have continued to multiply, and it is obvious that the present review has had to be content with a sample of the principal psychological theories. It is also obvious that none of the theories discussed so far is near to being considered adequate. Doubtless the steady proliferation of theoretical speculation is related to the lack of success of earlier attempts.

We are thus left with two further problems for discussion. Firstly, there is the problem of why the theories put forward have been so lacking in success. Secondly, whether it is possible to suggest ways for a more successful theoretical approach.
explanation of the effects of E.C.T. would help investigations into the nature and causes of mental illnesses, particularly depression.

Secondly, and more seriously, the work on the effects of E.C.T. has revealed little well-established information, even when the vast literature on the subject has been carefully combed (63). It is known fairly definitely that E.C.T. is beneficial in cases of endogenous depression, that it has an effect on the recall of past events and that it causes confusion. Systematic exploration of these effects has generally not been attempted; a notable exception being the work of Cronholm and his associates.

A third reason for the lack of success in theorizing is that in many instances the theories put forward have been highly speculative, based on clinical impressions only, and not tied down to experimentally established phenomena. Such theories, besides often being difficult or impossible to test, have no more validity than the impressions or assumptions on which they are based and seem merely to confuse the issue.

Suggestions for Better Lines of Approach

A much-neglected source of inspiration for workers concerned with E.C.T. is the work on the effects of E.C.S. in animals. This is due presumably to the fact that most work on E.C.T. is done by psychiatrists, whilst that on E.C.S. with animals is done mainly by experimental psychologists. The animal work could present a useful model for E.C.T. research, as it is much better executed as far as the experiments are concerned, the relevant parameters are well explored (at least for the R.A. effect) and the theorizing is more closely tied to experimental findings.

The main suggestion coming from the above review of animal research is that of a two-factor theory of E.C.S. in terms of the interruption of memory traces and also a confusion effect produced when several E.C.S.s are administered within a short period of time. That this latter confusion effect may be particularly important in explaining the effects of E.C.T. on human psychiatric patients is also suggested by the frequent mention of confusion in clinical reports of E.C.T. It is possible, for example, that E.C.T.'s effectiveness may be partially spurious, as a series of E.C.T.s may mask the true illness because of the induced state of confusion, in much the same way as a series of E.C.S.s given to a rat have been found to produce a learned response. Unfortunately, little experimental research has been done on E.C.T. confusion. That which has been done (55, 72) has done little more than show its existence experimentally.

Experiments using unilateral E.C.T. (47) are also of theoretical interest. These suggest that memory disturbances and confusion following E.C.T. may be less if the electrodes are placed unilaterally as opposed to the more usual bilateral placements. Further experimental exploration of the use of unilateral E.C.T. could contribute greatly to the determination of the role played by memory disturbance and confusion, and possibly other factors, in the therapeutic effects of E.C.T.

Conclusions

The main, unavoidable conclusion arising out of this review is that we have come very little way towards explaining the effects of E.C.T. Explanations that have been put forward tend to have been speculative and unconvinced. The outstanding fact that emerges is that an explanation of the phenomena can only be adequate as the data on which it is based. As the experimental data on the effects of E.C.T. are so poor, the biggest contribution of theoretical significance in this field must come from more careful and detailed exploration of the effects of E.C.T. and the parameters on which they depend. Without this, further theoretical development will be greatly hindered, if not impossible.

It is further suggested that help in the solution of the problem may be obtained from utilizing the results of experimentation on animals as such research has certain advantages over that using human patients. Work on unilateral E.C.T. also presents interesting possibilities.

Acknowledgments

The writer would like to acknowledge the helpful advice of Mr. C. B. Blakemore of the Institute of Psychiatry and Mr. A. R. Dabbs of Oakwood Hospital in the preparation of this paper.
C.T.s may mask the patient's induced state of confusion by the efficiency and retentivity of depressed patients. Unfortunately, little research has been done on this. That which has been done has been more than show the effects of electroshock therapy. british Med. J., 1941, 262-270.


PSYCHOLOGICAL THEORIES OF E.C.T.: A REVIEW


Edgar Miller, B.Sc., Clinical Psychologist, Oakwood Hospital, Maidstone, Kent; Present address: Unit for Research on Medical Applications of Psychology (University of Cambridge), 5 Salisbury Villas, Station Road, Cambridge

Received 29 March, 1966
