

# Experimental Studies of the Electroshock Process

MAX FINK, M.D., ROBERT L. KAHN, PH.D., and MARTIN A. GREEN, M.D.

In the last seven years, increasing study by various authors<sup>1-5</sup> of the neurophysiologic alterations occurring in electroshock has resulted in a re-assessment of the mode of action of this form of therapy. The present neurophysiologic-adaptive hypothesis<sup>1,2</sup> states that an induced change in brain function provides the milieu in which behavioral changes can occur, depending upon the characterologic predisposition of the subject.

This report summarizes the data of three groups of studies which have been completed in the continuing evaluation of the electroshock process in this laboratory. These include:

1. The relation of changes in neurophysiologic indices to behavioral change;
2. Types of psychologic response expressed and factors in the evaluation of "improvement;" and
3. The role of personality in the behavioral response.

## I. Subjects and Method:

The studies have been carried out in groups of consecutive, unselected electroshock referrals. The subjects are voluntary patients in an open ward psychiatric hospital. All patients are treated by resident psychiatrists, who make the referral to the electroshock therapy unit. The duration and type of therapy, however, are determined by the supervising psychiatrists in charge of the treatment unit. Patients varied in age from 20 to 66, and have been diagnosed as suffering from depressive and schizophrenic illnesses.

(a) *Tests of Brain Function*: Two indices of cerebral function have been stressed: Quantitative measures of the degree of induced delta activity in the electroencephalogram,<sup>6</sup> and changes in orientation and awareness of illness after amobarbital sodium.<sup>7</sup>

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1) *EEG*: Electroencephalograms were done weekly prior to treatment, and on a day following a treatment. Bipolar recording was used, and selected leads were measured for the degree of delta activity. The average percent time delta for each of these selected leads, the highest delta index in any one lead, the highest amplitude and slowest frequency of delta, and the longest duration of bursts were the measures utilized in the classification of the records into "high degree," "moderate degree" and "low degree delta activity."<sup>6</sup>

2) *Amobarbital Test*: This is a structured interview, in which the patient is asked a standard set of questions pertaining to orientation and awareness of illness. Amobarbital is then administered intravenously, in a concentration based upon body weight, at a rate of 1 cc to every 40 seconds, until nystagmus and slurred speech are induced. In the initial series, a 5% solution of amobarbital was administered at the rate of 1 cc per minute. Recently, to permit simultaneous estimates of the sedation threshold,<sup>8</sup> the procedure was modified to allow for weight differences of subjects. The same questions are repeated, and persistent changes in orientation, denial of illness, confabulation, and reduplication are called "positive" and are indicative of states of altered cerebral function.<sup>7</sup> Tests were carried out before electroshock, and at weekly intervals during electroshock on the day following treatment.

(b) *Evaluation of Behavior*: In addition to the notes of the patient's therapist and supervising psychiatrist, all patients were seen by the research psychiatrist at weekly intervals during treatment and 2-4 weeks after the last treatment. Evaluation of changes in behavior induced by electroshock were based on these descriptions. Ratings of improvement were based on the behavioral response two to three weeks after the last treatment, and reflect a short term clinical rating. The patients were divided into three groups: much improved, moderately improved and unimproved, based on criteria described.<sup>2</sup>

(c) *Evaluation of Personality*: The initial method of personality assessment employed has been a structured family interview. In their original observations, Weinstein and Kahn described the characteristics of the "explicit verbal denial personality."<sup>9</sup> To determine the significance of this personality type for behavioral response, a structured questionnaire was developed. In interviews with two members of the family, the patient's usual attitudes and interests in 15 specific areas were explored. Each characteristic was rated as being absent, moderately present or markedly present. Scores of 0, 1 and 2, respectively, were assigned, and added—the resulting score being termed the "denial personality score."<sup>10</sup>

(d) *Treatment*: Electroshock was administered on a schedule of three treatments a week. A minimum of 12 treatments was given, except in a few cases where a severe confusional state appeared earlier. The course of treatment was determined by the supervising psychiatrist in charge of the electroshock unit, based upon clinical criteria. Treatments were grand mal, using either a Medcraft alternating current instrument or a Reiter C-47 electrostimulator. Patients were generally premedicated with intravenous Pentothal prior to the treatment.

In the past year, a subconvulsive therapy group was instituted. Randomly selected electroshock referrals received 12-42 subconvulsive treatments, under Pentothal premedication. These patients were subjected to the same test procedures and the same behavioral evaluations as the grand mal therapy subjects. Neither the psychiatrist making the evaluation, the patient's therapist, nor the patient was cognizant of which patients received which form of therapy. The data for this series of patients is now being evaluated, and reference will be made only to the general observations.

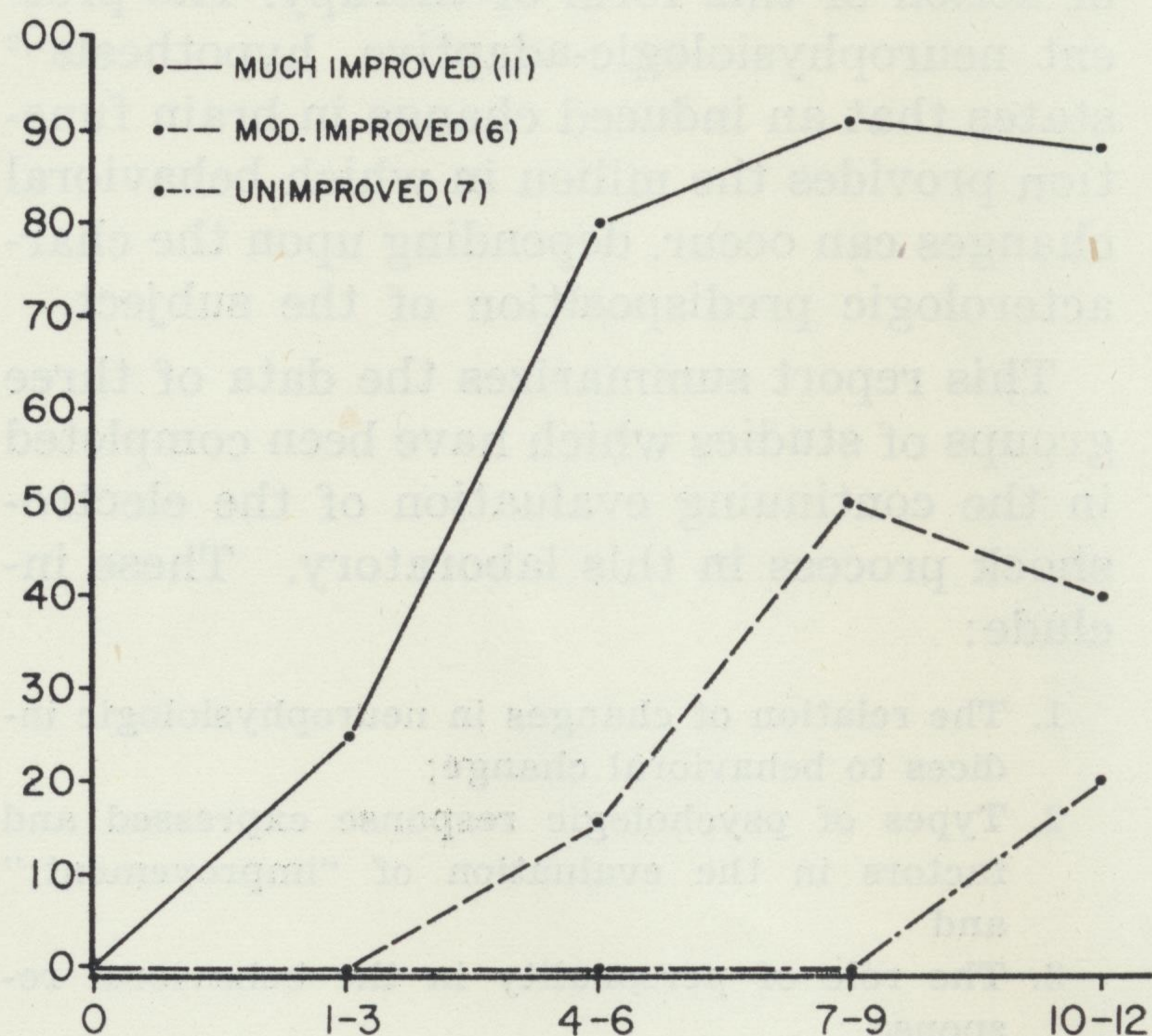
## II. Observations:

### (a) *Role of Altered Cerebral Function in Behavior*:

#### 1. *Electroencephalogram*:

In these studies, we have emphasized the degree of delta activity. In the initial series of patients a direct relationship was noted between the early development and

maintenance of high degree delta activity and short term clinical ratings.<sup>6</sup> Of the patients who were rated much improved, 90% had high degree delta EEG records in the 3rd and 4th weeks of treatment, while of the unimproved patients, only 20% had such records. The relationship between delta activity and clinical ratings is seen in Figure 1.



In subsequent series, these observations were extended in a predictive study. Based on the earlier observations, it was suggested that the much improved patients were those in whom high degree delta activity had been induced early in the course of treatment and sustained. Records during the second and third weeks of treatment, therefore, were assessed. The results in 54 consecutive patients are noted in Table I. Of the patients who developed high degree delta activity during the second and third weeks of treatment, 67% were rated much improved, while only 30% of the patients without such activity were so rated.

TABLE I

*Patients With High Delta Activity During Second, Third Weeks of Treatment*

EEG Delta	CLINICAL RATING		
	Much Improved	Moderately Improved	Unimproved
Both High (18)	12 (67%)	4 (22%)	2 (11%)
One High (16)	4 (25%)	8 (50%)	4 (25%)
None High (20)	6 (30%)	7 (35%)	7 (35%)

## 2. Amobarbital Test:

In the initial series of 24 patients, previously reported,<sup>2</sup> eleven patients were rated as much improved, and all had positive amobarbital test reactions after 7 to 9 treatments and sustained this response. Of the unimproved patients, 15% had positive amobarbital responses in the third week and 28% in the fourth week, but these were not sustained.

A comparison of both the EEG observations and the amobarbital test data, as related to the eventual clinical rating is seen in Table II. In 77 patients tested to date, observations during the second and third weeks of treatment were examined for the presence of high degree delta activity and positive amobarbital test results. Of the much improved patients, 75% had both positive amobarbital tests and high EEG delta activity during this period. Of the unimproved patients, however, 57% had neither positive amobarbital tests nor high EEG delta activity. It is apparent that the cluster of positive amobarbital tests, high EEG delta activity and much improved clinical ratings is a significant one; and equally significant is the cluster of negative amobarbital tests, low and moderate EEG delta activity and clinical rating of unimproved.

TABLE II

*EEG and Amobarbital Test Results During Second, Third Weeks of Treatment\**

	Much Improved	Moderately Improved	Unimproved
Both Positive Amobarbital and High EEG Delta Activity .....	25	10	3
Either Positive Amobarbital or High EEG Delta Activity .....	8	12	5
Neither Positive Amobarbital nor High EEG Delta Activity .....	0	3	11
Total .....	33	25	19

\*Significant at better than .01 level of confidence.

### (b) *Clinical Patterns of Behavior:*

In these patients, we have observed varied responses to electroshock including the absence of noticeable symptoms with a return of pre-morbid behavior; hypomania, euphoria, and denial; paranoid states with

ideas of reference and delusional formation; confusional states with varying degrees of memory disturbance; increased somatic complaints and preoccupations, states of increased panic, excitement and agitation and varying degrees of withdrawal, and seclusiveness. The degree of behavioral change is seen to be related to the degree of alteration in the neurophysiologic indices. During electroshock, with the gradual induction of states of altered brain function, and their restitution in the weeks following cessation of therapy, behavior shows characteristic patterns. The following are but a few of the gross patterns that are observed during the period of increasing and waning states of altered brain function.

An early change in behavior in retarded subjects, for example, may be a change in the degree of participation in ward activities and increased neatness and interest in personal care. This is succeeded by a phase of minimizing symptoms and displacement of complaints, mild euphoria, denial of illness, and insistence upon going home. At this time, the EEG shows the greatest degree of delta activity and amobarbital tests are positive. With the cessation of treatment, the overactivity diminishes, and interest in the future becomes prominent. Premorbid patterns of behavior are in evidence, and the EEG returns to normal and the amobarbital test becomes negative.

Other depressed subjects, however, become increasingly disturbed during treatment, withdraw from participation in hospital activities, and complain increasingly of memory loss, physical distress and insomnia. Amobarbital tests and electroencephalograms may show the same degree of change as in the first group. With cessation of treatment, there is either a return to the depressed state, or a persistent emphasis on the memory loss and physical complaints of the treatment.

Another pattern, seen in hostile, negativistic and withdrawn patients, is the development of hyperactive, hypomanic, and impulsive behavior. Memory loss is marked, and clinical disorientation and confusion may be noted at the height of neurophysiologic change. After treatment is ended, ideas of reference, negativism and delusional for-

mation become prominent, to be followed by withdrawal and mutism.

(c) *Effect of Subconvulsive Therapy:*

The interdependence of these adaptive patterns with the state of altered brain function is more clearly demonstrated by observations in the subconvulsive group. Twenty-seven subjects received subconvulsive therapy instead of grand mal. Minimal changes in the electroencephalogram and in amobarbital tests were induced, and the changes in clinical behavior were limited. The electroencephalograms demonstrated either no delta or a minimal amount of such activity. In no patient were moderate or high degree delta activity records observed. In the amobarbital tests, only three patients had positive tests during treatment, and in each instance it occurred only once. No change in symptoms or behavior was noted in twenty-three. Nineteen were referred for a second course of treatment. Grand mal electroshock induced changes in brain function of high degree delta activity and/or repeated positive amobarbital tests in fourteen of these. All fourteen showed significant changes in behavior; while of the five patients in whom the physiologic indices showed only minor changes, only two patients showed a definite behavioral change.

(d) *Role of Personality in the Adaptive Response:*

Another variable in the adaptive response of the patients is the personality—the habitual attitudes, patterns of perception and behavior and defenses of the patient. The initial study of the role of personality related the characterological disposition of patients showing denial mechanisms to the clinical result. The relatives of 47 patients were interviewed, and denial personality scores assessed. Scores ranged from 0 to 25, with a median of 11. The scores were divided into two groups: scores from 11 to 25 were classed as the “high denial group” and those from 0-10 as the “low denial group.”

Of the patients with high denial personality scores (Table III), 58% were in the much improved group, and only one patient (4%) was in the unimproved group. The ratings of improvement for the patients with low denial personality scores were random—

about one third appearing in each rating category.

TABLE III

*Relation of Denial Personality Scores to Clinical Response to Electroshock*

Personality Score	Much Improved	Moderately Improved	Unimproved	Total
11-25	14	9	1	24
0-10	7	9	7	23
Total	21	18	8	47

The difference in the denial scores between the much or the moderately improved patients, when compared to the unimproved patients, is statistically significant.

That the personality ratings were indeed reflective of the patients' adaptive response under the conditions of altered brain function is noted in the correlation of these scores with actual changes in language patterns which had been described<sup>11</sup> as indicative of denial responses. As in that study, changes in language in structured interviews with the patient were studied. Each patient was classified according to whether he showed three or more explicit language changes. The group of patients with high denial personality scores showed a significantly greater number of language changes than patients with low personality scores. The coefficient of correlation is +.71, which is significant at better than the 1% level of confidence.

III. Discussion:

These studies of the neurophysiologic and psychologic aspects of electroshock support and amplify the hypothesis of electroshock action initially expressed by Weinstein, Linn and Kahn,<sup>1</sup> and again by Kahn, Fink and Weinstein,<sup>2</sup> and the observations of Roth,<sup>3</sup> Aird,<sup>4</sup> and Ulett.<sup>5a, b</sup> Alteration in brain function is the central effect of electroshock therapy, and is a pre-requisite to behavioral change. We have emphasized delta activity in the electroencephalogram and the patterns of disorientation, confabulation, and denial of illness after amobarbital as indices of altered brain function. Other measures, applied in the same serial fashion, will, we believe, demonstrate the same relation to changes in behavior or alteration in brain function.

Under the conditions of the induced

change in brain function, altered patterns of adaptation are expressed. The type of adaptation varies, apparently dependent upon the personality organization. In these studies we have noted the relationship of an "explicit verbal denial" personality type with the development and maintenance of clinical language patterns of denial, displacement, and minimization in structured interviews.<sup>11</sup> We have observed that patients with high denial scores are those who are more likely to be evaluated as "much improved" (Table III). The type of adaptation is varied, however, as we have described here. In this context, therefore, the conclusion is affirmed that electroshock is a means of inducing change in cerebral function in which altered patterns of adaptive-interpersonal behavior can be sustained.

We have emphasized "change in behavior" in this report. In previous studies, we related our observation to "improvement." "Improvement" is a derivative evaluation of the induced behavioral change, which is dependent upon the expectations of the therapist, the family, or the administrator, in the milieu in which the behavior is observed. When a depressed patient, who had been withdrawn, crying, and had expressed suicidal thoughts, no longer is seclusive, and is jovial, friendly and euphoric, denies his problems and sees his previous thoughts of suicide as "silly," a rating of "much improved" is made. To the extent that a schizophrenic patient is perceived as less delusional, less excited, and less withdrawn, he is rated as "improved." When, however, the induced behavior is one of increased anxiety and fearfulness, or persistent complaints about memory loss, pain or other physical symptoms, or excitement and delusional thoughts, a rating of "unimproved" will be made.

These studies amplify the present neurophysiologic-adaptive hypothesis of electroshock action. Further studies, defining the significant aspects of personality and of the expectations of the environment on the patterns of behavior which are observed under the condition of altered brain function are suggested. Application of this hypothesis to the effect of newer tranquilizing agents is in progress. Finally, studies of individual differences in the neurophysiologic response

to equivalent amounts of cerebral trauma warrants exploration.

#### IV. Summary and Conclusions:

1. This report summarizes continuing experimental studies of the mode of action of electroshock therapy.

2. Behavioral change in electroshock is dependent upon an alteration in brain function as evidenced by serial changes in delta activity in the electroencephalogram and disorientation and confabulation with intravenous amobarbital.

3. The pattern of behavioral alteration is shown to vary markedly, depending upon the degree of induced cerebral dysfunction, the personality of the subject and the environmental situation.

4. "Improvement" ratings are seen as a special case of behavioral change dependent upon the type of adaptation elicited, the expectation of the therapist, administrator and family, and the tolerance of the milieu.

5. The extension of this neurophysiologic-adaptive hypothesis of electroshock action to other forms of somatic therapies is suggested.

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*Dev. Nerv. System*

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This report summarizes the data of three groups of studies which have been completed in the continuing evaluation of the electroshock process in this laboratory. These include:

- 1) The relation of changes in neurophysiologic indices in behavioral change;
- 2) types of psychologic response expressed and factors in the evaluation of "improvement;" and
- 3) the role of personality in the behavioral response.

## II. Subjects and Method:

The studies have been carried out in groups of consecutive, unselected electroshock referrals. The subjects are voluntary patients in an open ward psychiatric hospital. All patients are treated by resident psychiatrists, who make the referral to the electroshock therapy unit. The duration and type of therapy, however, are determined by the supervising psychiatrist in charge of the treatment unit. Patients varied in age from 20 to 66, and have been diagnosed as suffering from depressive and schizophrenic illnesses.

(a) Tests of Brain Function: Two indices of the cerebral function have been stressed: Quantitative measures of the degree of induced delta activity in the electroencephalogram, (6) and changes in orientation and awareness of illness after amobarbital sodium (7).

1) EEG: Electroencephalograms were done weekly prior to treatment, and on a day following a treatment. Bipolar recording was used, and selected leads were measured for the degree of delta activity. The average percent time delta for each of these selected leads, the highest delta index in any one lead, the highest amplitude and slowest frequency of delta, and the longest duration of bursts were the measures utilized in the classification of the records into "high degree," "moderate degree" and "low degree delta activity" (7).

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(b) Evaluation of Behavior: In addition to the notes of the patient's therapist and supervising psychiatrist, all patients were seen by the research psychiatrist at weekly intervals during treatment and 2-4 weeks after the last treatment. Evaluation of changes in behavior induced by electroshock were based on these descriptions. Ratings of improvement were based on the behavioral response two to three weeks after the last treatment, and reflect a short term clinical rating. The patients were divided into three groups: much improved, moderately improved and unimproved, based on criteria described ( ).

(c) Evaluation of Personality: The initial method of personality assessment employed has been a structured family interview. In their original observations, Weinstein and Kahn described the characteristics of the "explicit verbal denial personality" (9). To determine the significance of this personality type for behavioral response, a structured questionnaire was developed. In interviews with two members of the family, the patient's usual attitudes and interests in 15 specific areas were explored. Each characteristic was rated as being absent, moderately present or markedly present. Scores of 0, 1 and 2, respectively, were assigned, and added - the resulting score being termed the "denial personality score" (10).

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cases where a severe confusional state appeared earlier. The course of treatment was determined by the supervising psychiatrist in charge of the electroshock unit, based upon clinical criteria. Treatments were grand mal, using either a Medcraft alternating current instrument or a Reiter C-47 electrostimulator. Patients were generally premedicated with intravenous pentothal prior to the treatment.

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III. Observations:

A. Role of Altered Cerebral Function in Behavior:

1. Electroencephalogram:

In these studies, we have emphasized the degree of delta activity. In the initial series of patients a direct relationship was noted between the early development and maintenance of high degree delta activity and short term clinical ratings (6). Of the patients who were rated much improved, 90% had high degree delta EEG records in the 3rd and 4th weeks of treatment, while of the unimproved patients, only 20% had such records. The relationship between delta activity and clinical ratings is seen in Figure 1.

In subsequent series, these observations were extended in a predictive study. Based on the earlier observations, it was suggested that the much improved patients were those in whom high degree delta activity had been induced early in the course of treatment and sustained. Records during the second and third weeks of treatment, therefore, were assessed. The results in 54 consecutive patients are noted in Table I. Of the patients who developed high degree delta activity during the second and third weeks of treatment, 67% were rated much improved, while only 30% of the patients without such activity were so rated.

TABLE I

Patients with High Delta Activity During Second, Third Weeks of Treatment.

<u>EEG Delta</u>	<u>Clinical Rating</u>		
	<u>Much Improved</u>	<u>Moderately Improved</u>	<u>Unimproved</u>
Both High (18)	12 (67%)	4 (22%)	2 (11%)
One High (16)	4 (25%)	8 (50%)	4 (25%)
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## 2. Amobarbital Test:

In the initial series of 24 patients, previously reported (2), eleven patients were rated as much improved, and all had positive amobarbital test reactions after 7 to 9 treatments and sustained this response. Of the unimproved patients, 15% had positive amobarbital responses in the third week and 28% in the fourth week, but these were not sustained.

A comparison of both the EEG observations and the amobarbital test data, as related to the eventual clinical rating is seen in Table II. In 77 patients tested to date, observations during the second and third weeks of treatment were examined for the presence of high degree delta activity and positive amobarbital test results. Of the much improved patients, 75% had both positive amobarbital tests and high EEG delta activity during this period. Of the unimproved patients, however, 57% had neither positive amobarbital tests nor high EEG delta activity. It is apparent that the cluster of positive amobarbital tests, high EEG delta activity and much improved clinical ratings is a significant one; and equally significant is the cluster of negative amobarbital tests, low and moderate EEG delta activity and clinical rating of unimproved.

TABLE II

EEG and Amobarbital Test Results During Second, Third Weeks of Treatment.\*

	<u>Much Improved</u>	<u>Moderately Improved</u>	<u>Unimproved</u>
Both Positive Amobarbital and High EEG Delta Activity	25	10	3
Either Positive Amobarbital or High EEG Delta Activity	8	12	5
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(Total)	(33)	(25)	(19)

B. Clinical Patterns of Behavior:

In these patients, we have observed varied responses to electroshock including the absence of noticeable symptoms with a return of pre-morbid behavior; hypomania, euphoria, and denial; paranoid states with ideas of reference and delusional formation; confusional states with varying degrees of memory disturbance; increased somatic complaints and preoccupations, states of increased panic, excitement and agitation and varying degrees of withdrawal, and seclusiveness. The degree of behavioral change is seen to be related to the degree of alteration in the neurophysiologic indices. During electroshock, with the gradual induction of states of altered brain function, and their restitution in the weeks following cessation of therapy, behavior shows characteristic patterns. The following are but a few of the gross patterns that are observed during the period of increasing and waning states of altered brain function.

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#### C. Effect of Subconvulsive Therapy:

The interdependence of these adaptive patterns with the state of altered brain function is more clearly demonstrated by observations in the subconvulsive group. Twenty-seven subjects received subconvulsive

therapy instead of grand mal. Minimal changes in the electroencephalogram and in amobarbital tests were induced, and the changes in clinical behavior were limited. The electroencephalograms demonstrated either no delta or a minimal amount of such activity. In no patient were moderate or high degree delta activity records observed. In the amobarbital tests, only three patients had positive tests during treatment, and in each instance it occurred only once. No change in symptoms or behavior was noted in twenty-three. Nineteen were referred for a second course of treatment. Grand mal electroshock induced changes in brain function of high degree delta activity and/or repeated positive amobarbital tests in fourteen of these. All fourteen showed significant changes in behavior; while of the five patients in whom the physiologic indices showed only minor changes, only two patients showed a definite behavioral change.

D. Role of Personality in the Adaptive Response:

Another variable in the adaptive response of the patient is the personality - the habitual attitudes, patterns of perception and behavior and defenses of the patient. The initial study of the role of personality related the characterological disposition of patients showing denial mechanisms to the clinical result. The relatives of 47 patients were interviewed, and denial personality scores assessed. Scores ranged from 0 to 25, with a median of 11. The scores were divided into two groups: scores from 11 to 25 were classes as the "high denial group" and those from 0 - 10 as the "low denial group."

Of the patients with high denial personality scores (Table III), 58% were in the much improved group, and only one patient (4%) was in

the unimproved group. The ratings of improvement for the patients with low denial personality scores were random - about one third appearing in each rating category.

TABLE III

Relation of Denial Personality Scores to Clinical Response to Electroshock

<u>Personality Score</u>	<u>Much Improved</u>	<u>Moderately Improved</u>	<u>Unimproved</u>	<u>Total</u>
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Total	21	18	8	47

The difference in the denial scores between the much or the moderately improved patients, when compared to the unimproved patients, is statistically significant.

That the personality ratings were indeed reflective of the patients' adaptive response under the conditions of altered brain function is noted in the correlation of these scores with actual changes in language patterns which had been described (11) as indicative of denial responses. As in that study, changes in language in structured interviews with the patient were studied. Each patient was classified according to whether or not he showed three or more explicit language changes. The group of patients with high denial personality scores showed a significantly greater number of language changes than patients with low personality scores. The coefficient of correlation is  $+0.71$ , which is significant at better than the 1% level of confidence.

#### IV. Discussion:

These studies of the neurophysiologic and psychologic aspects of electroshock support and amplify the hypothesis of electroshock action initially expressed by Weinstein, Linn and Kahn (1), and again by Kahn, Fink and Weinstein (2), and the observations of Roth (3), Aird (4), and Ulett (5a, b). Alteration in brain function is the central effect of electroshock therapy, and is a pre-requisite to behavioral change. We have emphasized delta activity in the electroencephalogram and the patterns of disorientation, confabulation, and denial of illness after amobarbital as indices of altered brain function. Other measures, applied in the same serial fashion, will, we believe, demonstrate the same relation to changes in behavior or alteration in brain function.

Under the conditions of the induced change in brain function, altered patterns of adaptation are expressed. The type of adaptation varies, apparently dependent upon the personality organization. In these studies we have noted the relationship of an "explicit verbal denial" personality type with the development and maintenance of clinical language patterns of denial, displacement, and minimization in structured interviews (11). We have observed that patients with high denial scores are those who are more likely to be evaluated as "much improved" (Table III). The type of adaptation is varied, however, as we have described here. In this context, therefore, the conclusion is affirmed that electroshock is a means of inducing change in cerebral function in which altered patterns of adaptive-interpersonal behavior can be sustained.

We have emphasized "change in behavior" in this report. In previous studies, we related our observation to "improvement." "Improvement"

is a derivative evaluation of the induced behavioral change, which is dependent upon the expectations of the therapist, the family, or the administrator, in the milieu in which the behavior is observed. When a depressed patient, who had been withdrawn, crying, and had expressed suicidal thoughts, no longer is seclusive, and is jovial, friendly and euphoric, denies his problems and sees his previous thoughts of suicide as "silly," a rating of "much improved" is made. To the extent that a schizophrenic patient is perceived as less delusional, less excited, and less withdrawn, he is rated as "improved." When, however, the induced behavior is one of increased anxiety and fearfulness, or persistent complaints about memory loss, pain or other physical symptoms, or excitement and delusional thoughts, a rating of "unimproved" will be made.

These studies amplify the present neurophysiologic-adaptive hypothesis of electroshock action. Further studies, defining the significant aspects of personality and of the expectations of the environment on the patterns of behavior which are observed under the condition of altered brain function are suggested. Application of this hypothesis to the effect of newer tranquillizing agents is in progress. Finally, studies of individual differences in the neurophysiologic response to equivalent amounts of cerebral trauma warrants exploration.

V. Summary and Conclusions:

1. This report summarizes continuing experimental studies of the mode of action of electroshock therapy.
2. Behavioral change in electroshock is dependent upon an alteration in brain function as evidenced by serial changes in delta activity in the electroencephalogram and disorientation and confabulation with intravenous amobarbital.
3. The pattern of behavioral alteration is shown to vary markedly, depending upon the degree of induced cerebral dysfunction, the personality of the subject and the environmental situation.
4. "Improvement" ratings are seen as a special case of behavioral change dependent upon the type of adaptation elicited, the expectation of the therapist, administrator and family, and the tolerance of the milieu.
5. The extension of this neurophysiologic-adaptive hypothesis of electroshock action to other forms of somatic therapies is suggested.

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