ECT: memory loss

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PSYCHOLOGIC EFFECTS OF ELECTRIC CONVULSIVE TREATMENTS

(II. Changes in Word Association Reactions)

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THE PROBLEM

The results described in the first article of this series (1) showed that four weeks after termination of electric convulsive treatments (ECT), the patients displayed marked difficulty in recalling past experiences. Is the memory disturbance limited to the recall of events in the patient's life history, or does it extend to other tasks which require similar recall processes to come into play? The quantitative data provided by a word association test may be expected to throw some light on this problem since, as Woodworth (11) has pointed out, "The association experiment . . . makes use of associations which have been formed in the ordinary course of life . . . [It] deals with the ordinary materials of thought and reveals something of the process of handling such materials." Since the spontaneous associations elicited by the word stimuli tend to be "recalled" responses based on prior learning, an investigation of the association disturbances occurring on a word association test may provide some clues to the nature of the alteration in association processes underlying the difficulty in recalling personal experiences.†

PROCEDURES

The word association test employed in this study consisted of 100 stimulus words. Of the 80 standard words, used with all of the patients, 57 were obtained from the Orbison list described by Rapaport et al. (7) and the other 23 were from the Kent Rosanoff list (8). Twenty additional words were especially selected as "emotionally toned" for each patient on the basis of case history material. These nonstandard words were distributed throughout the test so that one occurred after every four or five standard stimulus words.

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†In the literature on convulsive treatments three studies are to be found in which a word association test was applied (5, 9, 12), but none of them was designed to provide systematic results on changes in association disturbances attributable to the interpolation of convulsive treatments. So far as this particular problem is concerned, the three studies supply incomplete and mutually contradictory information.

The standard list contained a heavy loading of words which are, at least potentially, emotionally disturbing and, when combined with the 20 words which were individually selected for their personal "trauma" value, the list of 100 words became heavily saturated with stimuli likely to produce strong affective reactions. This sort of list was used intentionally because in an exploratory study of this kind the results might prove to be of little value unless an effort were made to guarantee that a sufficient number of association disturbances would occur so as to make comparisons possible.

The procedures for administering the word association test described by Rapaport et al. (7) were followed with respect to standardized instructions, the measurement of reaction times, the manner of handling misunderstood stimulus words, and the repetition of relevant portions of the instructions when nonconformity occurs.

Subjects

The word association test was administered to 17 ECT patients shortly before they began electroshock treatments. The test was repeated approximately four weeks after each patient had completed the last treatment of the series. The ECT patients received a minimum of 10 electroshock treatments, the mean being 17.8 treatments. The mean time interval between the pre-treatment and the post-treatment test was 12.0 weeks. For the equated control group of 17 patients a comparable interval was used between the two administrations of the test (a mean of 11.1 weeks). The patients in the control group received no form of shock treatment during the interval, although none of them had been specifically excluded from such treatment on the basis of symptomatology, prognosis or any other psychiatric considerations.

The control group was equated with the ECT group on a variety of relevant characteristics. The mean age of each group was 31.1 years and 27.4 years, respectively; the mean number of years of formal schooling was 9.8 and 10.1, respectively. Only 3 of the control cases and 4 of the ECT cases had been previously hospitalized. In each group, 13 of the 17 patients had been in the hospital for less than 60 days at the time of the initial word association test. According to the case history records, the duration of the mental disorder was less than one year for 7 of the controls and for 6 of the ECT patients; it was more than four years for only 2 control and 3 ECT patients.

The two groups were also fairly well equated with respect to occupation, sex and diagnosis. There were 12 schizophrenics in the control group and 11 in the ECT group, with about equal numbers subclassified as paranoid, catatonic, and mixed. In each group there was one

patient classified as manic depressive psychosis and the remaining cases were diagnosed as psychoneurosis or as borderline schizophrenia.

Results

From the extensive literature on the word association method a comprehensive list of the many different forms of "disturbed" and "pathologic" reactions was constructed, representing a wide variety of deviations from the test instructions or from norms derived from large sample studies of "normal" subjects. For purposes of psychologic analysis, these deviations will be treated under three general headings: delayed reaction time, deviant word associations and defective reproduction.

Changes in Delayed Reactions.—A primary purpose of investigating the reaction time of word associations is to obtain an indication of the amount of "blocking" due to emotional or other causes, exhibited by each subject in the course of the test. Consequently the data have been analyzed in terms of the frequency of reactions which were delayed by more than a specified time interval. There is no specific time interval which may be designated as an absolute criterion for a "delayed" reaction, but three seconds or longer appears to be an adequate one on the basis of the range of normal reaction times reported in the literature (11).

It was found that in the after-test there was a mean decrease of 7.0 delayed responses for the ECT group and of 4.8 for the control group. The difference is not statistically reliable, even when differences in the initial test performances are taken into consideration. Two additional criteria of delayed reactions were investigated: (1) the number of responses delayed for five seconds or more, and (2) the number of failures to respond within the time limit of 45 seconds. With respect to each of these criteria, the ECT group as well as the control group showed a slight decrease in the number of delayed reactions; on the basis of a statistical analysis of the changes exhibited by the two groups, it was found that the differences were definitely not reliable. Since the results fail to show a reliable difference between the ECT group and the control group on any of the three measures of delayed reaction, it appears that ECT had no observable effect on the frequency with which delayed associations occurred.

Changes in Deviant Associations.—Deviant word associations include almost all of the major "complex indicators" or "disturbed" reactions other than those involving reaction time or reproduction. From an exhaustive list of the association disturbances which have been described in the literature, 13 different types were differentiated for

purposes of the present investigation: remote or idiosyncratic associations, multi-word responses, stimulus repetitions, stimulus derivatives, verbal comments, word completions, value responses, rhyming responses, non-meaningful words, unusual parts of speech, self-references, vulgar responses and direct perseverations.*

Considering first the entire set of deviant associations, it was found that following ECT there is a relative increase in the average number of responses containing at least one type of deviation. The ECT patients displayed a mean increase of 1.88 deviant responses, when re-tested approximately four weeks after the last convulsive treatment. In contrast, the control patients displayed a mean decrease of 4.41 deviant responses in their after-test performance. This difference is statistically reliable ($t=2.7$) and is not attributable to the influence of such artifacts as initial inequality between the two groups. Consequently the results indicate that electroshock treatments tend to produce a relative increase in the number of "disturbed" word association reactions.

In order to determine which of the various types of deviant responses are primarily affected, the results were broken down into 13 different types of deviations. It was observed that pronounced changes occurred only for the following:

(1) Remote or idiosyncratic associations, i.e., responses which have no apparent semantical relationship to the stimulus word;†

(2) Multi-word responses, i.e., failures to limit the response to one word as directed by the test instructions;

(3) Stimulus repetitions, i.e., responses which consist of an exact repetition of the stimulus word.

For each of the three types of deviation, there was a substantial difference between the mean changes of the two groups. For purposes of statistical analysis, they were combined by tabulating the number of responses showing at least one of the three types of deviation. On the pretreatment test the average number of deviant responses for the ECT group was 10.4. Approximately four weeks after treatment there was an average increase of 2.8 deviant responses. The corresponding

*Cf. the second paragraph below for definitions of the first three categories. Precise definitions were used in scoring the remaining ten types of deviant associations, based upon those given in current manuals (7, 8). Typescript copies of the rules for scoring deviant associations are available from the author.

†The definition of this category used in scoring the records is in terms of the absence of any of the relationships between the stimulus and response word which have been reported in the literature as usual or popular ones. The following were specified as usual or popular relationships: synonymity, antonymity, co-ordination, supra-ordination, subordination, causality, function or utility, common properties of the object denoted and usual participants in the activity denoted.

results for the control group showed an average decrease of 4.8 deviant responses, from 18.4 on the initial test to 13.6 on the final test.

Since the means for the two groups were not equal initially, analysis of covariance was applied in order to render them equivalent for statistical treatment (6). The results of the statistical analysis indicate that the net increase in deviant responses shown by the ECT group is definitely reliable.* It may be concluded, therefore, that electric convulsive treatments had the effect of increasing certain types of deviant associations: remote or idiosyncratic associations, stimulus repetitions and multi-word responses.

In evaluating this finding, it is necessary to consider the possibility that the ECT patients may have exhibited a corresponding decrease in other types of deviant associations. If this were the case, it would mitigate, to some extent, the implication that ECT has a detrimental effect upon the association processes tapped by the word association test.

In order to obtain precise information on this point, a separate tabulation was made of the number of responses containing at least one of the remaining 10 types of deviant associations. Statistical analysis of the results revealed that the difference between the mean changes of the two groups was negligible. A check was also made on two additional types of reaction which resemble certain of the deviant associations included in this study and which have been proposed by Jung (3) as additional "complex indicators": (a) mishearing the stimulus word and (b) repeating the stimulus word automatically, before giving the response proper. It was found that there was no reliable change on either of these two types of reaction.

As was pointed out earlier, the association disturbances included in this study represent almost all of the "complex indicators" which have been suggested in the literature. It seems safe to conclude, therefore, that the relative increase in the three types of deviant associations exhibited by the ECT patients was not compensated by a decrease in other types of association disturbances. The detailed results on which this conclusion is based are consistent with the general finding described at the beginning of this section, namely, that electroshock

*The F-value was 5.95 which has a corresponding probability value below 5%. A check was also made on the reliability of the scoring of the three types of deviant responses by having 16 records scored completely independently by another judge. It was found that there was very high agreement between the two judges: there was no discrepancy on the scoring of 97% of the 1600 responses. For this reliability check, the author is indebted to Miss Anne D. Kennard, Assistant, Department of Psychology, Columbia University.

treatments tend to produce an increase in the average number of stimulus words which are reacted to in a disturbed fashion.

Changes in Defective Reproduction.—The purpose of the reproduction test is to determine the ability of the subject to reproduce his association reactions. Immediately after the word association test proper the list of stimulus words was presented again and the patient was instructed to repeat the response he had just given to each word. Three subcategories of defective reproduction were scored:

(1) a marked delay in giving the reproduction (reaction time of three seconds or longer);
(2) wholly incorrect reproduction
  (a) false reproduction or
  (b) no answer or "don't know" as the only response within the time limit of 45 seconds;
(3) partially incorrect reproduction
  (a) giving the same root-word as the word association but with a syntactical change or
  (b) giving a false reproduction immediately followed by a spontaneous correction.

From the tabulation of reproduction responses, it was observed that on all three types the ECT patients showed a relative increase in the mean number of defectively reproduced responses on the after-test (as compared with the control group). The results were then analyzed in detail for the combination of all three types of defective reproduction, i.e., in terms of the total number of reproductions which were defective in any of the three ways. The results show that the mean number of defective reproductions for the 17 ECT patients increased from 36.6 to 47.5, whereas the mean for the 17 control patients remained almost unchanged, at 42. To test the statistical reliability of this differential change, analysis of covariance was applied and it was found that the difference was definitely reliable ($F=6.64$). Hence, it appears that a series of electroshock treatments has the effect of increasing the number of defective reproductions.

Discussion

The Increase in Deviant Associations.—In evaluating the results obtained from the word association test, it is necessary to bear in mind the fact that association disturbances are generally described as indicators of emotional disturbances and of psychopathologic mental processes (3, 7, 8, 11). The three types of deviant associations which were found to increase following ECT are generally regarded as exceedingly pathologic reactions. Remote or idiosyncratic associations, stimulus-

repetitions and multi-word reactions appear to be closely similar to the types of deviation which have been reported as occurring more frequently in psychotics than in normals and more frequently in young children and in feebleminded adults than in normal adults.

It would not be at all surprising to find an increase in remote or idiosyncratic associations, stimulus-repetitions and multi-word responses, had the ECT patients been tested during the period when, as part of the organic reaction to the treatments, cognitive functions are temporarily impaired (4, 10). But the post-treatment test was given approximately four weeks after the final treatment, at a time when, according to their physicians and ward nurses, the patients no longer manifested any signs of the organic reactions which had been observed during the period of electroshock treatments.

The finding that there is an increase in pathognomonic reactions following ECT should be regarded as tentative until carefully checked by future research studies employing larger samples and new lists of stimulus-words. There are several reasons why confirmatory studies are necessary before fully accepting the conclusion that ECT tends to produce an increase in pathologic types of disturbed association reactions:

(1) The average increase in the three types of content deviation is largely due to a relatively small number of ECT cases* who showed substantial increments; the average increase proved to be statistically reliable because most patients in the control group showed a decrease in such reactions in their after-test performances, probably as a practice effect (11). Hence, it is a *relative* increase in the three types of association disturbances which is shown by the ECT patients—a trend discernible by statistical analysis of group results but not observable in each individual case.

(2) The increase in association disturbances may prove to be characteristic only for responses to stimulus-words of the type used in this experiment rather than for any list of words. As was pointed out above, the word list used in the present study was heavily saturated with "emotionally toned" words. It is possible that the relative increase in association disturbances following ECT may occur for this type of word list but not for those composed exclusively of "neutral" words.

*In substantial agreement with Zeaman's findings (12), a breakdown of the results in terms of clinical improvement status (as rated by psychiatrists) shows that those ECT patients who had improved clinically were somewhat less likely to show an increase in association disturbances than those who were unimproved. Nevertheless, even the subgroup of improved ECT patients displayed an average increase in the three types of deviant associations and in defective reproductions whereas both the improved and the unimproved subgroups of control patients displayed an average decrease.

Despite the limitations just discussed, the evidence presented in the preceding section is unequivocal in showing that on the particular word association test employed in this study the ECT group did display a significant increase in certain types of pathognomonic reactions, without a compensatory decrease in other types of deviations. To obtain some insight into the psychologic processes underlying the observed association disturbances, it is worthwhile to consider in some detail the nature of each of the three types of deviant responses which were found to increase following ECT.

Multi-word reactions and stimulus-repetitions are essentially failures to carry out the instructions given to the subject at the beginning of the association test. It is unlikely that they are due to misunderstanding of the instructions because in administering the test it was standard practice to repeat the relevant instructions the first time that each deviation occurred. Moreover, many of the verbal comments given by ECT patients in the post-treatment test show explicitly that they were aware of their error, as is illustrated by the following examples:

> Dark—" 'No light.' I'll change it to 'lightness' because it should be one word."
>
> Spring—" 'Part of the year.' I should say only one word, though."

It appears that such reactions occurred despite the fact that the patients comprehended the instructions. This suggests that the difficulty is, in part, a failure to maintain the "set" imposed by the association test instructions. Stimulus-repetition is clearly a failure to carry out the task of giving "free associations" to the stimulus words. Multi-word reactions were most often attempted definitions, which also may be regarded as an avoidance of the task by spontaneously adopting a "defining" set instead of allowing oneself to give "the first word that comes to mind."

Some of the remote or idiosyncratic responses appear also to be characterized by the same kind of failure to maintain the task set, especially those which were obviously due to *object naming*, i.e., responding by naming objects in the examiner's room. Other cases of remote association appeared to involve some form of perseveration. Sometimes it seemed that the remote response was mediated by associations to the preceding reaction-word rather than to the present stimulus-word. For example, in the after-test one of the ECT patients gave the following successive responses: *Vagina*—"woman"; *Farm*—"man." Another type of perseverative trend could occasionally be detected from the high frequency of repetition of the same response throughout the record as in the case of an ECT patient who gave the response "mother," to 11

different stimulus words on the post-treatment test; in 5 cases the word was appropriate to the stimulus-word (e.g., *woman*—"mother") and was not scored as remote but in the other 6 cases there was no apparent semantical relationship to the stimulus-word (e.g., mountain—"mother"). Thus, although separate scoring was not attempted because of the occurrence of many borderline cases, a substantial number of remote or idiosyncratic reactions is undoubtedly due to perseverative tendencies, which, like stimulus-repetition and multi-word definitions, represent failures to maintain the task set of giving spontaneous associations to the stimulus-words. The failure to maintain the task set occasionally seemed to be deliberate, as in the case of object naming, but most often it seemed to be unintentional or involuntary, as in the multi-word reactions which the patients knew to be unacceptable.

The Increase in Defective Reproductions.—At first glance, the finding that there is a reliable increase in incorrect and delayed reproductions following ECT suggests that the defect may be a disturbance in *immediate memory* functions, since the reproduction test requires the subject to recall the responses he had given only a few minutes earlier on the word association test. While this interpretation of the results cannot be excluded, it appears to be less probable than an alternative interpretation, namely, that the increase in defective reproduction reflects a greater degree of *instability* in the association processes underlying both the word association test proper and the reproduction test.

First of all, previous studies on the effects of electric convulsive treatments provide objective evidence that within about two weeks after the conclusion of the series of treatments, immediate memory is no longer impaired, i.e., the ability to recall immediately preceding events reaches or exceeds the pre-treatment level. (4, 10) Secondly, clinical observations of performances on the reproduction test suggest that the ability to give correct reproductions is only partly determined by immediate memory ability and that a more important factor may be the stability of the associative response to the stimulus-words. This is emphasized by Rapaport et al. (7): "In the Reproduction Test the same *attitude* [of conformity with the word association test instructions] is brought into play as in the test proper, and this is how the amazing accuracy of reproduction is accounted for."

A *stable* reaction* may be defined as a response which occurs promptly and without alteration every time the same stimulus-situation is presented. The word association response given to a stimulus-word may be regarded as a complex verbal habit and the concept of "stability

*The term "stable" as applied to reactions on the word association test was introduced into the literature by J. Zeaman (12).

of the reaction" is analogous to that of "habit-strength" applied to other types of learned responses. The reproduction test, since it presents the same stimulus-words a second time, provides a test of the stability of the word association responses. Hence, the results on defective reproduction may reflect a decrease in the stability of word association reactions among the ECT patients, and this may be due to any of a variety of factors which could interfere with the habit-strength of a response.

The hypothesis that electroshock treatments tend to decrease the stability of word association reactions appears to be consistent with the hypothesis derived from the results on the three types of deviant associations which were found to increase following ECT. Failure to maintain the task-set results in a failure to produce the habitual associations ordinarily elicited by the test instructions and this could account for the decrease in the ability of the ECT patients to reproduce their word association reactions accurately.

If a patient conforms with the instructions and gives a reaction free from association disturbance, his response is likely to be a fairly well established association habit. Such an habitual response would most likely be readily reproduced on the reproduction test. But if the patient fails to carry out the task by repeating the stimulus-word, by naming some random object in the room, by giving a multi-word definition of the stimulus-word or by fixing his attention upon one of his preceding responses rather than upon the current stimulus-word, etc., then, he gives a spurious reaction, determined by chance factors of the moment, rather than a well established response. When confronted by the task of reproducing his reaction, the patient might give either a "genuine" association or another spurious reaction, again determined by extraneous momentary conditions; in either case, the reproduction is likely to be defective. Thus, failure to maintain the "task-set," whether for emotional or other causes, is likely to lead to fluctuating, unstable responses.* If this assumption is correct, the results on defective reproduction tend to bear out the hypothesis based on the three types of deviant associations, namely, that following ECT there is an increased tendency to fail to maintain the "task-set" imposed by the word association test instructions.

The Nature of the Post-treatment Memory Disturbance.—The preceding article of this series, on post-ECT amnesias (1), revealed that

*Indirect evidence supporting this assumption is provided by the results on 7 ECT patients reported by Zeaman (12). She found that those reactions which were free from complex-indicators (nondeviant associations) in the pre-treatment records were more likely than the disturbed reactions to be correctly reproduced (stable) and to occur unchanged in the post-treatment association test (persistent). Similar relationships were noted in the data obtained in the present study.

there is some form of impairment in recall processes which persists beyond the usual recovery period following the termination of treatments. It was pointed out that following ECT there appears to be a relatively extensive disturbance affecting even those memories which the patients were able to produce in the post-treatment interviews. In addition to the evidence on post-treatment amnesias, the following observations were described which appeared to differentiate markedly the performances of the ECT patients from those of the control patients:

(1) Numerous instances were observed in which ECT patients displayed purely temporary amnesias, i.e., they were unable to recall a particular experience in one interview session but were able to recall it in a subsequent one.

(2) It was noted that the ECT patients required an inordinate amount of detailed questioning, providing many memory cues, in order to elicit some of the memories which they were able to reproduce in full detail.

(3) In general, the ECT patients appeared to expend an unusual amount of effort in producing adequate answers to questions about their past lives, including material on their school and job histories.

These observations imply that the memory impairment is not restricted to the sustained circumscribed amnesias found after ECT but extends to other personal memories as well.

If this hypothesis is correct, it might be expected that there would be some form of increased difficulty in producing word association reactions since, as was pointed out at the beginning of this article, such reactions are likely to be personal responses based on prior learning. This prediction appears to be borne out by the empirical findings.

Despite whatever clinical improvement may have been produced by the electroshock treatments and despite the apparent decline in emotional tension (2), an increase in certain types of disturbances in associative processes did emerge, without any apparent compensatory decrease in other forms of association disturbances.

As has already been emphasized, from the results of the present study alone one cannot draw a definitive conclusion about the effect of ECT upon the association processes involved in word association performances *in general,* not only because of the usual limitations of any small sample study, but also because of the special characteristics of the list of stimulus-words. Nevertheless, as far as they go, the findings indicate that following ECT there is some kind of interference with the normal production of habitual verbal associations.

For the present it may be worth while to pursue the implications of this interpretation of the findings, since, by doing so, some fruitful re-

search leads may emerge. Assuming, on a purely tentative basis, that the findings of the word association test reflect the basic features of the impairment in recall processes following ECT, what do the detailed findings suggest, with respect to the specific nature of the impairment? First of all, the fact there was no significant change in delayed reactions suggests that the association disturbance is not a matter of "blocking," of "having nothing come to mind," when the patient attempts to associate to a given idea or symbolic cue. Apparently something does come to mind as rapidly as ever, but the difficulty seems to lie in the kind of associations which occur. It was pointed out above that the specific types of disturbances which showed a relative increase following ECT seem to imply difficulty in maintaining the "task-set," a failure to produce the type of associations ordinarily given in response to the test instructions; the failure appears to be a form of evasion, perhaps of an involuntary character.

To say that failure to maintain the "task-set" occurs is equivalent to saying that the habitual association is inhibited or supplanted by the occurrence of some other response. The psychologic mechanism is probably similar in its consequences to "retroactive inhibition," although the conditions that produce it may be dissimilar.

If, as we are tentatively assuming, disturbances on the word association test reflect the nature of the disturbance in the actual association processes of everyday life, one would predict that after electroshock treatments a patient would exhibit some difficulty in those tasks which require him to bring into play his repertoire of habitual symbolic associations.

Since ECT patients have not been found to display any persistent deficit in verbal tests of intelligence (4, 10), there is apparently no difficulty following ECT in giving definitions of words or in dealing with similar tasks involving impersonal types of symbolic material. Nevertheless there is the possibility—although at present it would appear to have low probability—that more precise tests of cognitive symbolic functions may reveal some subtle form of impairment. Further investigations are needed to test the hypothesis that the primary memory defect following ECT may be a generalized interference with habitual symbolic associations, affecting to some degree all previously learned symbolic responses. But whether or not this general hypothesis should prove to be correct, a more limited hypothesis remains to be considered, namely, that failure to adopt or maintain the "task-set" may tend to occur whenever the patient is required to produce symbolic associations which have personal significance for him, such as would be involved in the task of recalling his own past experiences. For example, if asked, "What

was the first school you went to?" the usual chain of associations (whether images, verbal symbols or some other form of implicit symbolic response) might fail to occur immediately. Instead of automatically adopting the set necessary to deliver relevant associations, the ECT patient might be repeating to himself the verbal cue, "first school I went to" (similar to stimulus-repetition) or redefining the question to himself (similar to multi-word definitions) or thinking of some irrelevant idea (similar to remote or idiosyncratic associations). Whatever the nature of the interfering responses, so long as they prevent the immediate occurrence of the habitual associations, they would tend to cause irrelevant answers and a delay before the patient is able to arrive at the appropriate memory. The increased occurrence of irrelevant associations (which interfere with the production of the relevant habitual associations underlying the recall of past events) might account for the qualitative observation that during the post-treatment memory interviews the ECT patients seemed to require more time to answer questions about their past life, and to respond with more irrelevant material than they did in the pre-treatment interviews (1).

Zubin (13) studied interference effects after a *single* electric convulsive treatment by requiring the patients to learn a series of paired associates prior to the treatment and then, after the treatment, having them learn a second set of associates to the same stimulus words. From his findings he concluded that ECT does not eliminate interference effects but, rather, seems to augment them. It cannot be assumed that Zubin's results necessarily reflect the same type of memory impairment as that involved in the word association disturbances. Yet the finding that a single electroshock treatment augments some sort of interference effect seems to be consonant with the "association-interference" hypothesis. It remains for future research to explore the hypothesis further by investigating a wide variety of interference effects after recovery from the temporary "organic" syndrome following an entire series of electric convulsive treatments.

Summary and Conclusions

Seventeen mental patients who received a minimum of 10 electric convulsive treatments were given a word association test before the electroshock series began and again four weeks after the series had ended. When the changes in their performances were compared with those exhibited by an equated control group of 17 patients who received no form of shock treatment during a comparable time interval, the following findings and conclusions emerged:

(1) No reliable change was found on any of the following measures

of delayed reaction: (a) responses delayed for three seconds or more, (b) responses delayed for five seconds or more, (c) failure to respond within the 45 second time limit. From these findings it appears that ECT had no observable effect upon the frequency with which delayed associations occurred.

(2) The ECT group exhibited a slight but statistically reliable increase in certain types of deviant associations: (a) remote or idiosyncratic associations, (b) stimulus repetitions, (c) multi-word responses. The ECT patients showed no decrease in other types of association disturbances which would in any way compensate for the average increase in these three types of pathologic association disturbances.

(3) The ECT group exhibited a statistically reliable increase in defective reproductions of the word association responses, indicating that as a result of electroshock treatments the patients tended to give a poorer performance on the reproduction test.

(4) From a qualitative examination of the three types of deviant associations which were found to increase following ECT, it appears that a primary characteristic is failure to maintain the "task-set," (imposed by the word association test instructions) which is necessary for producing habitual association responses. The results on defective reproductions of word association reactions are consistent with this interpretation, on the assumption that if the "task-set" is not maintained the associations are not likely to be stable, habitual ones. Consequently the results of this investigation lend tentative support to the following hypothesis: the post-treatment amnesias and related difficulties in producing personal memories following electric convulsive treatments (reported in the preceding article of this series) may arise from a basic disturbance in recall processes, consisting of an increased tendency to produce spurious, irrelevant associations which interfere with the production of the habitual associations necessary for evoking the recall of personal past experiences.

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