TESTS OF PSYCHOMOTOR EFFICIENCY IN PATIENTS TREATED WITH METRAZOL.*

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Introduction.

Many different opinions are held about the value of metrazol (cardiazol) shock treatment. Large quantities of statistics are available which compare the recovery rates of treated and untreated patients (Bateman and Michael, 1940). Studies of the objective changes in treated cases have been less frequent. The present communication describes some experimental work directed towards elucidating clinical changes in patients treated with metrazol at the Ontario Hospital, London. Three psycho-physiological tests were employed: reaction time, tapping rate and strength of grip were measured. Psycho-physiological measurements, formerly used extensively (Kraepelin, 1920), have, for some years, been discredited as means for obtaining information about abnormal mental states (Stoddart, 1926). They retain their popularity as aids to the measurement of the effects of drugs such as alcohol and benzedrine (Thornton, Holck and Smith, 1939), and they have been used for the rating of general mental efficiency in aviators (Stamm, 1920), or as tests for loss of function due to anoxia (McFarland and Barach, 1937). Every test carries with it an element of experimental error and, in watching for improved performance attributable to a drug's effect, special care has to be taken to ascertain what improvement, if any, could be attributed to chance factors, to practice or to familiarity. Thus, the additional study of repeated performances of normal adults and control patients in the same test situation is necessary. It has, in the past, been amply demonstrated that the performances of psychotic patients on psychomotor tests are less efficient than those of normal people (Dorcas and Schaffer, 1934). Reaction time is lengthened, tapping rate slowed and strength of grip diminished. Moreover, an abnormal degree of variability in the response is common (Whipple, 1925) because the efficiency of some patients changes capriciously during a test. Other patients are found to show even less variety than normals (Shakow and Huston, 1936).

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The experiments described here were carried out with standard psychological equipment, for the loan of which the writers are greatly indebted to Prof. R. B. Liddy and Dr. D. J. Wilson, of the Department of Psychology, University of Western Ontario. The apparatus included tapping key for reaction time, tapping board, electrical recording on revolving drum with waxed paper and electrical chronometer.

Reaction Time to Auditory Stimulus.

Though attractive in theory, experiments with reaction time on psychotic patients prove difficult to carry out. If co-operation is poor, uncertainty prevails as to whether the patient's response is a reaction or an independent movement. The subjects, also, are limited to those whose special senses are intact. In the present study the measurement of the time between the stimulus of the sound of a tapping key and the subject's reaction of tapping once with a stylus was attempted. Three trials were given, which were not scored, and the mean of ten reaction times was then taken. The average for unpractised adult normals in the same situation was found to be 0.18 seconds, and scores ranged from 0·11 to 0·24 seconds. Few patients selected for metrazol therapy were sufficiently co-operative for useful comparisons before and after treatment to be made. The records in three typical cases may be of some interest, however. (See Table I.) Most patients showed reaction times significantly greater than normal at the first test and, after a few treatments, reactions of normal speed were consistently obtained. No similar improvement was found in control patients retested after intervals in which no treatments were given.

Dynamometer Reading.

An attempt was made to ascertain whether metrazol treatment had any effect upon the strength of grip in the hands as measured by a dynamometer. Each time the mean of four readings was taken: two tries with the right and two with the left hand were made alternately. The average value for 29 male patients was 32·5 kgm., and for females 13·7 kgm.; these readings were far below the normal values of about 50 kgm. and 25 kgm. respectively. Unfortunately the amount of variation from day to day was so great in the control group of patients that to demonstrate a statistically significant improvement in cases treated with metrazol would have required a much larger number of cases than were available to the writers. In individual cases, however, there was a marked improvement in strength of grip during the treatment period. (See Table I.) In a study of the effects of benzedrine, Thornton and others (1939) were unable to show significant changes in dynamometer readings, though some other psycho-physiological activities were heightened when the subject was under the influence of the drug.

TABLE I.—*Results of Psychomotor Tests in Three Treated Patients.*

(i) Male patient, B—, aged 19, catatonic schizophrenia, duration 4 months; result—social remission.

Number of days since first test	0	9	16	24	31	45	62
Total number of metrazol treatments	0	1	3	6	8	11	11
Reaction time to sound (seconds)	—	0·30	0·23	0·17	0·17	—	—
Dynamometer (kilograms)	36	—	38	41	46	46	48
Tapping rate (number of taps per 5 seconds)	27·1	27·6	28·9	29·8	33·3	33·6	31·1

(ii) Female patient, A—, aged 45, involutional melancholia, duration 10 months; result—social remission.

Number of days since first test	0	9	15	25	39	46
Total number of metrazol treatments	0	0	2	5	6	6
Reaction time to sound (seconds)	—	0·33	0·20	0·19	0·22	—
Dynamometer (kilograms)	—	10	16	13	16	17
Tapping rate (number of taps per 5 seconds)	23·9	—	29·7	35·9	34·2	33·0

(iii) Female patient G—, aged 48, paranoid manic state, duration 11 months; result—full remission.

Number of days since first test	0	0	10	21	33	
Total number of metrazol treatments	0	1	3	5	5	
Reaction time to sound (seconds)	—	0·72	0·84	0·25	0·17	
Dynamometer (kilograms)	—	—	19	20	25	
Tapping rate (number of taps per 5 seconds)	—	7·0	19·4	28·6	32·0	

SPEED OF TAPPING.

Measurement of tapping rate is a very convenient test for the purpose in hand for several reasons. Speed of tapping is a personal characteristic which is not closely correlated with any other known ability (Hart, and Spearman,

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1914), and, unless practised frequently, the speed varies little for the same person from time to time. Moreover, considerable freedom of expression can be allowed to the subject in his manner of performing the test. In the simple tapping test on one board, the mode of reaction of the subject to the request to tap with the stylus as fast as possible is instructive to watch. The task is so simple that co-operation can be obtained even with patients who are acutely ill.

Manic patients, as a rule, work rapidly (Strong, 1913), but seldom exceed a normal average score because they waste energy in hitting the board too forcibly. In acutely excited states, the variability of speed from moment to moment is noticeably increased. Depressed patients tap more slowly than they would if they were not depressed ; if they also are apprehensive or agitated they show marked variations of speed. In stupor, the rate is very slow and variation usually less than the normal ; the monotonous slow tapping obtained in catatonics is remarkable and contrasts sharply with the capricious, discontinuous type of response shown by other patients with typically schizophrenic symptoms, who jump from one speed to another for no apparent reason. Deteriorated patients waste time by making patterns with the stylus on the tapping plate. Patients with paranoid symptoms but otherwise well adjusted tend to show normal speeds, but often they have less variety of response than normal people.

The form of the test used in the present study was adapted from that recommended by Wells (1909). The subject was required to tap for four periods of a little more than 20 seconds with either hand. In every case the right hand was taken first for 20 seconds, then the left, then again the right, and so on. In counting the strokes the initial second in every period was discarded. The number of taps in each of the four consecutive five-second intervals, for both hands (32 intervals altogether), was counted. The average number of taps per five seconds for the two hands, ascertained in 24 normals, tested for the first time, was 32·7 ; the smallest normal score was 27·7, and the largest 43·4. This largest score approached closely the value 42·5 given by Whipple for thoroughly practised adults. The scores of these normal subjects showed high reliability on retesting after a long or a short period of time. The scores of 49 patients tested for the first time averaged only 23·4 and ranged from 3·0. to 35·0. On retesting patients who, at the time of investigation, were not under metrazol therapy, no tendency to improvement was observed.

The results of tests on 30 patients who were treated with metrazol are summarized in Table II, and are compared with the results of control experiments. There were 15 males and 15 females in this group ; on the average they each received 10·3 treatments. Treatment was never administered more often than twice in a week, and the average period between one treatment and the next was five days. In order to exclude, as far as possible, any effects of practice or familiarity in the test results, the tapping experiments were spaced

TABLE II.—*Summary of Observations on Change in Tapping Rate.**

	Normals.	Patients not under metrazol treatment.	Patients under metrazol treatment.
Number of male subjects	12	23	15
Number of female subjects	18	14	15
Number test-retest intervals (n)	30	42	92
Mean length of interval in days	43·8	18·2	18·9
Number of treatments per interval	0	0	3·4
Change in tapping rate per interval	−0·31	−1·00	+2·61
Standard deviation of change (σ)	±1·45	±3·49	±5·87
Standard error of change ($\sigma/\sqrt{n-1}$)	±0·27	±0·54	±0·61

* Expressed as number of taps per 5 seconds.

out at intervals which ranged from one to four weeks. Each patient was tested about four times so that, from the beginning to the end of the period of treatment, there were about three test-retest intervals. Patients were not tested until at least 24 hours had elapsed after a treatment. Improvement in the tapping rate of patients under treatment was consistently observed, and it is unlikely that these changes in rate could have been due to chance. The average increase in number of taps per 5 seconds was over four times its standard error.

In order to explore the field further, an analysis was made of the relationship of the improvement in score to the number of treatments which had been given in the test-retest interval. In the first place, the 92 intervals could be divided into two groups according to whether all the treatments within that period had resulted in major convulsions or not. In the one group of 63 intervals there had been, in all, 179 major convulsions, and the improvement in score per treatment was plus 0·89. In the other group of 29 intervals there had been 95 major convulsions and 35 failures, that is, 27 per cent. subconvulsive treatments ; in this second group of intervals the improvement in score per treatment was only plus 0·66. The comparison indicates that subconvulsive doses did not contribute appreciably to the improvement in score. In the second place, evidence was obtained which showed that improvement in tapping rate was greatest in the early phases of treatment. The amount of improvement in tapping rate per treatment decreased steadily as the number of treatments increased. (See Table III.) After about the twelfth treatment the average

TABLE III.—*Change in Tapping Rate and Number of Treatments.*

Treatment rank.	Number of treated patients whose changes in score contribute to aggregate (*p*).		Aggregate change in score for each treatment rank (*s*).*		Mean rise or fall per patient per treatment rank (*s*/*p*).	
1st	26		37·8		1·5	
2nd	27		44·3		1·6	
3rd	27		43·4		1·6	
4th	27		37·1		1·4	
5th	27		37·0		1·4	
6th	25		16·1		0·6	
7th	21		18·8		0·9	
8th	19		19·2		1·0	
9th	17		12·8		0·8	
10th	14		3·0		0·2	
11th	13		6·4		0·5	
12th	10		−0·1		0·0	
13th	9		0·1		0·0	
14th	9		−3·8		−0·4	
15th	9		−5·5		−0·6	
16th	7		−4·2		−0·6	
17th	7		−4·2		−0·6	
18th	6		−9·0		−1·4	
19th	4		−8·7		−2·1	
20th	3	15	−3·1	−18·8	−1·0	−1·3
21st	1		1·0		1·0	
22nd	1		1·0		1·0	
1st–22nd	309		242·4		0·8	

* The process by which this column was compiled is as follows: If a patient's score after the $(n_1)^{th}$ treatment was (s_1) and his score after the $(n_2)^{th}$ was (s_2), the change in score in this test-retest interval was spread over the range of treatments from the $(n_1)^{th}$ to the $(n_2)^{th}$; the contribution to the aggregate change, in each treatment rank thus specified, was a quantity $(s_2 - s_1)/(n_2 - n_1)$.

patient showed no increase in score, and most of those whose treatment was continued beyond this period began to show a decline in tapping speed. Recent work on the effect of metrazol treatment upon intelligence test scores (Wittman, 1939) has given similar results to those recorded here: a rise up till the ninth treatment, and a subsequent gradual fall was reported. A method of pooling, for all the patients, the changes in score from test to test, was used in the present survey; it seems to dispose of the ambiguity caused by the unavoidable differences in length of treatment for different cases when, as in previous work, absolute test scores are used.

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Relationship of Test Score to Clinical State.

Psycho-physiological tests only touch one aspect of the personality, and an exact relationship between clinical changes and alteration in reaction time or in tapping rate is not likely to be found in every patient. The association between degree of remission noted at the end of the course of metrazol treatment and the total change in tapping rate observed in the same period was weak, but significantly positive in the 30 cases ($r = +0{\cdot}38 \pm 0{\cdot}17$). This association might have been more marked but for the fact that a few patients, who benefited greatly therapeutically, were too agitated to be tested at all before one or two treatments had been given. The type of correspondence which was found between mental state and psychomotor ability is best understood by examining individual histories. The mental state of the patient B—, whose scores are shown in Table I, for example, improved greatly during the treatment, and so also did his scores on all the psychomotor tests ; the result was classified as a social remission. Another patient, A—, in Table I, showed a similar concomitant change in mental condition and test scores. She was sent home on probation soon after the last tests were done, and has remained well for twelve months. In the third case, G—, referred to in Table I, the changes were even more marked. The condition of the patient before treatment seemed almost hopeless. She was agitated, abusive and degraded in habits, but the clinical result after five convulsions was a full remission.

Dramatic changes were noted in stuporous cases, though not always in the direction of improvement. (See Diagram I.) One patient, E—, a male, aged 20, who had been in a catatonic stupor for several months, could not be induced to attempt the test before treatment, but, after three doses (two subconvulsive), he was able to score 11·1 in the tapping test. After five more convulsions his speed had increased to 33·7. The mental condition was so much improved that treatment was stopped and three weeks later he obtained a score of 33·9, just before being sent home on probation. In another case, however, C—, male, aged 25, with catatonic schizophrenia of four years' duration, although tapping rate rose from 5·6 to 31·3 after eight treatments (one subconvulsive), and although the patient became more alert, further treatment did not prevent him from relapsing to his former condition. After nine more doses (one subconvulsive), the tapping rate had fallen to 10·1 ; treatment was suspended, and a week later the tapping rate had dropped further to 6·6. The clinical result of the course of treatment was negligible, though the dynamometer reading rose from 34 kgm. to 44 kgm. in the period.

Of equal interest was the case of D—, female, aged 46, whose condition of agitated depression had lasted seven months. Before treatment, with much difficulty she was persuaded to co-operate sufficiently to produce a tapping rate of 3·1 ; the dynamometer reading was 9 kgm. After three convulsive

doses of metrazol the tapping rate was 13·7, and after two more such treatments it rose to 29·2 and the dynamometer reading was 16 kgm. The patient's mood was now cheerful, and she was sent home on probation but, unfortunately, she returned to hospital two weeks later in an apathetic state. The tapping rate was found to have fallen to 21.1. After six more treatments (one subconvulsive) the rate rose to 24·7, but it fell again after four more convulsions to

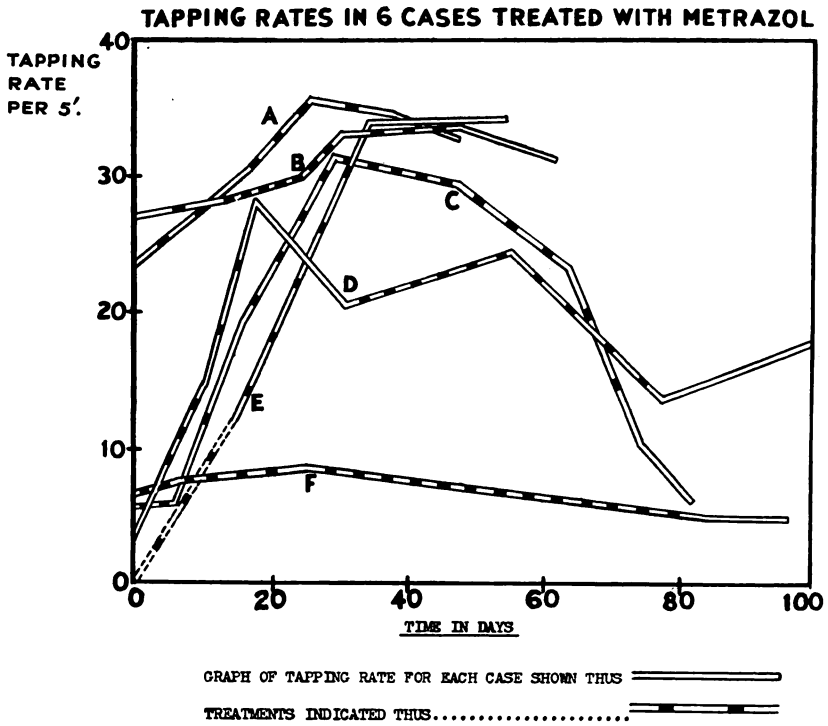

Diagram I.

13·8; the dynamometer reading remained between 16 and 17 kgm. during all this period. Treatment then had to be stopped on account of patient's high blood pressure and, though she is not agitated and does not seem very depressed, she now takes little interest in her surroundings.

Finally, a female patient, F—, aged 41, with schizophrenia of 16 years' duration had an initial tapping rate of 6·7. The rate rose only to 8·4 after the sixth treatment, and fell to 5·1 after the 18th treatment. The patient's mental condition was unchanged. There was little alteration in manometer reading, which remained at about 14 kgm. throughout the period of treatment.

COMMENTARY.

Some evidence has been brought forward which tends to show that psychomotor efficiency is increased by metrazol therapy. Such improvement cannot be directly due to the presence of the drug in the body, for the improvement is found long after the drug has all been excreted. Evidently a general easing of psychomotor activity is brought about by the convulsions themselves. The greatest facilitation seems to be produced by the first few treatments given. Thereafter the amount of improvement obtained in response to each convulsive dose tends to decline. The cause of the diminishing returns is not clear. The body may lose its sensitivity to the treatment on account of frequent repetition, or there may be a real loss of function due to the cumulative effect of cerebral traumata caused at each seizure.

The methods of measurement of psychomotor efficiency adopted here may have been faulty in some unforeseen way, but the general impression we obtained from the investigation was that they were of value in studying objective mental changes in cases treated by metrazol. Possibly more use could be made of psycho-physiological readings in the appraisal of other forms of treatment of mental diseases. It was noteworthy, however, that those patients who showed, before treatment, marked incompetence in tests of psychomotor activity, whether this was due to stupor or agitation, were those in whom the metrazol therapy was, on the whole, most effective. These patients were also those who showed general physical improvement exemplified by gain in weight. The study of the nature of the relationship between general physical health and the results of psychomotor tests, like numerous other problems which arose out of this work, would require discussion too lengthy to be included in the present communication.

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