THE EFFECTS OF EXERCISE UPON THE RETARDATION IN CONDITIONS OF DEPRESSION.

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The present paper deals with a small part of a research upon the physiological and psychological conditions in cases of retardation.[1] An attempt has been made to determine how much, if any, betterment this class of patients undergoes with exercise, both active and passive. The condition of retardation, and of the "feeling of inadequacy," which is very closely allied to retardation, we believe is one of lowered irritability, and any method that will help to bring the general irritability back to a more normal condition will be of benefit to such patients. Two clinical observations point strongly to the stimulating effect of exercise in this class of the insane, but such evidence has probably not been given sufficient value. The more noticeable of the two facts is that improvement in the mental condition of this class of patients is first noticed in the afternoon. After the activity of the morning the irritability seems to be increased to such an extent that the patient moves and answers more quickly and feels more nearly normal. The same stimulus seems to have a much greater effect in the afternoon than in the morning. The second fact is that after a restless night the retardation is often less marked and a condition is noticeable similar to the afternoon improvement. The loss of sleep, or, it may be, the restlessness of the night tends to "key up" the patient and the reactions are not so slow. In addition it may be mentioned that Hoch[2] has found that the "warming-up" effect in a case with the "feeling of inadequacy" is much greater than normal. On the separate days he found an

[1] The part here published is complete in itself but is now given mainly because of its suggestiveness and because it may help to emphasize the fruitfulness and importance of the application of psychological and physiological methods in psychiatry.

[2] On certain studies with the ergograph. Journal of Nervous and Mental Diseases, (1901), XXVIII, 620-628.

"unusual rise of pull number from curve to curve."[3] The lack of practice effect in Hoch's case and his conclusions will be considered later.

Two series of experiments have been made. The first series was with only one patient. In this series careful tests were made of his pressure and pain sensibility, of the rapidity and accuracy of movement, and the speed of reading. These experiments were made on days when he pursued his normal routine and on days when he had been subjected for five minutes to mechanical vibration along the extent of the spine. The second series was made with two retarded patients. The tests of this series included experiments upon simple and choice reaction times, upon the rapidity of movement, and upon the time of the more complex processes of reading and discrimination. These tests were made in the early morning at 8.30 or 9.00 and again two and a half hours later at 11.00 or 11.30. On alternate mornings exercise or rest was taken by the patient. On the resting days the subject was kept very quiet, lying down if possible, so that no extra muscular work was done, and on the exercised days for two hours between the two series of experiments the patient was taken for a long walk or on one day the patient was permitted to bowl during the interval.

The subjects for the experiment were two men: S., a merchant, is 44 years old. This is his third attack of depression. His first attack was at 20, and lasted five months. His second attack was at 33 and continued five months. The present attack began in March and now is practically over; duration six months. On entrance the patient was greatly retarded. He explained that he felt weak and could not put his mind on things. He would not answer questions, reacted little to pin pricks, and when asked to show his tongue made several unsuccessful attempts to do so. The other subject, Ev., has been depressed and retarded for nearly two years. This is his seventh attack of depression.[4]

[3] In a brief report of the continuation of this work Hoch reports similar results in more pronounced conditions of retardation in melancholia. Psychol. Bulletin, (1904), I, 255.

[4] This patient was used in a previous part of the research, and some of his results have already been published. Franz: Anomalous reaction times in a case of manic-depressive depression. Psychological Bulletin, 1905, II, 225-232.

SERIES I.—In the first series of experiments S. alone was used, and an effort was made to determine what effects followed the passive exercise and stimulation given by a mechanical vibrator. The subject was vibrated on alternate week days at 9 a. m. with a mechanical vibrator consisting of a vertical rod to which was attached a hard rubber ball 1¾ inches in diameter. This was pressed lightly against the skin over the points of exit of the nerve trunks, both to right and to left along the extent of the spine. Each point was vibrated five seconds.

On the days when the patient was not vibrated the tests were made at 9. a. m., and on the vibrated days the tests followed immediately the mechanical vibration. The first experiments made each day were the determinations of the touch and pain thresh-

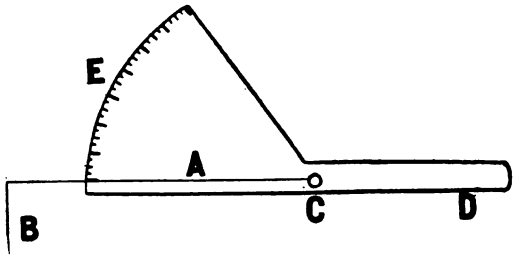

FIG. I.—The figure is about ¼ size of instrument.

olds. Then followed an experiment on the rapidity of movement, then the test on the accuracy of movement, next a test of the speed of reading, and finally a second test on the rapidity of movement.

Pressure sense threshold.—The touch threshold was determined by means of an instrument similar to that used by Bloch. The accompanying illustration will give an idea of the apparatus. To a piece of wood was attached a spring steel wire *A* which was bent at a right angle *B*. The long part of this wire, *A*, measured six inches. The area of cross-section of the wire was about .4 sq. mm. A scale *E* attached to the instrument permitted the experimenter to determine the threshold. The instrument measured pressures as high as 1¼ gms. The right-angled piece of the wire was pressed against the patient's skin, care being taken to keep it vertical all the time, and when the subject reported that the

pressure was perceived, the reading was taken from the scale and recorded. The following points on the skin were selected for the determination of the touch threshold: On the back 3 in. external to and level with the spinous processes of the 12th dorsal, of the 2d and the 4th lumbar vertebræ, and of the 4th sacral segment on either side, making in all 8 points. On the palm of each hand 19 points were selected as follows: the tips of the thumb and fingers, points midway between each of the phalangeal joints, and directly over each of the metacarpo-phalangeal joints. Care was taken not to select any calloused spots. Two determinations of the threshold were made on each of these points each day. A sufficient interval was permitted to elapse between the two tests to avoid any possible summation effect of the stimuli. Throughout these, as well as throughout all the other experiments, the patient co-operated very well. There was no indifference or unwillingness on his part during the progress of the series except on July 14th; the results on this day will be considered later. All the experiments on the back or on the palms for one day are grouped and averaged. The figures in the following tables are, therefore, to be understood as the daily averages of 76 experiments on the palms or of 16 experiments on the back.

Pain threshold.—The determination of the pain thresholds were made with an instrument similar to the well-known Cattell algometer, but the area of stimulation was approximately 2.5 sq. mm. The measurements of pain threshold were made on the same points used for the determination of the pressure threshold. The experiments on pain, however, were made after the touch experiments, and only one determination was made each day. The total number of observations each day was 38 on the palms of the hands, and 8 on the back. As in the case of the pressure threshold, all the measurements for the hands were grouped and averaged for each day, and a similar procedure was followed for the 8 daily pain determinations on the back.

Rapidity of movement.—The rapidity of movement was rather roughly tested by having the subject tap on a sheet of paper 8 by 10 inches with a pencil for 30 seconds. The subject was instructed to tap with the pencil as rapidly as possible from the time the signal for starting was given until told to stop. The total number of taps made in 30 seconds was counted and there-

from we calculated the average time for making one tap. The figures in the tables refer to this average time. Two experiments were made each day, and both of the averages are given in the accompanying tables.

The accuracy of movement.—A sheet of paper 8 by 10 inches was put before the subject and he was instructed to draw thereon a line. This line was then covered up and he was told to reproduce it. This was kept up until he had made 20 reproductions, each line being intended equal to the preceding one which he had drawn. The interval between drawing the lines was about 3 seconds. The length of line varied each day, but tended to be approximately 110 mm. long. The constant error in the reproduction of the lines was determined, *i. e.*, what tendency the patient had towards making his reproductions longer or shorter than the line which he was to reproduce. The average error was also calculated by taking the differences between the consecutive lines and averaging these, but disregarding any special tendency towards an increase or a decrease in his reproduction. Both the average constant error and the average error are, therefore, averages of twenty experiments each day.

Speed of reading.—During the last thirteen days of the series one experiment was made each day on the rapidity of reading 100 figures. The time given in the tables for these experiments is the total time for the 100 figures.

In the accompanying table will be found the results of all the experiments of this series for twenty-six days.[5] It will be noted that in the course of the experiments there was a gradual and steady improvement in the rapidity of movement, in the speed of reading, in the threshold for pressure, both on the palms and back, and for the pain threshold in both regions.

Contrary to the observations which have been made by other people, it will be noticed that the touch threshold in this patient

[5] On September 23, after the MSS. was sent to the JOURNAL, other experiments were made with S. Two experiments on tapping gave average times of .185 and .171 sec. respectively. Touch threshold for palms was .021 and for back .065 gms. Pain threshold for palms 440 and for back 456 gms. All these figures show a decided improvement in the patient. The day these experiments were made the patient was discharged "recovered." These results, therefore, may be considered *normal* for S.

TABLE I.

DAILY RESULTS AND AVERAGES. SUBJECT, S.

Dates.	Tapping time in sec.	Reading 100 figures sec.	Accuracy of Movement in mm.		Pressure Threshold in grams.		Pain Threshold in grams.	
			Constant Error.	Average Error.	Palms.	Back.	Palms.	Back.
July 6	.263	....	+0.95	3.75	....	....	....	....
7*	.227	....	+1.2	2.95	.190	....	909	....
8	.231 .252	....	+0.6	5.93	.257	....	931	....
10*	.205 .210	....	+0.38	7.40	.185	.181	922	822
11	.217 .216	....	−0.67	3.10	.231	.657	998	1020
12*	.203 .204	....	+1.7	5.35	.277	.395	984	988
1	216 .231	....	+0.5	4.55	.233	.352	978	921
14*[1]	.256 .248	....	+0.7	4.50	.334	.800	1012	1020
15	.226 .208	....	+1.2	4.13	.217	.274	965	1020
17*	.221 .207	....	+0.95	3.35	.147	.285	986	1010
18[2]	.205 .217	....	+0.55	4.80	.096	.151	802	886
19*	.197 .194	....	+0.5	5.68	.116	.276	811	855
20	.196 .208	45	+1.0	6.70	.137	.246	900	947
21*	.203 .199	43	+1.18	5.28	.118	.311	812	883
Aug. 8	.221 .207	42	+0.1	3.5	.088	.151	696	702
9*	.195 .194	40	+1.0	5.2	.085	.114	652	651
10[3]	.205 .194	42	+0.78	4.1	.060	.218	596	593
11*	.196 .192	41	+0.03	4.5	.075	.178	609	740
12	.195 .208	36	+0.4	4.5	.046	.155	588	644
14*	.192 .186	36	+0.25	4.7	.056	.125	636	676
15	.199 .190	35	+0.8	5.7	.078	.169	670	627
16*	.183 .182	35	+1.1	5.0	.064	.088	680	634
17	.200 .188	35	+1.15	5.0	.068	.105	631	600
18*	.183 .192	35	+0.85	6.3	.056	.137	602	577
19	.192 .211	36	+0.4	6.5	.043	.114	618	574
30	.192 .194[4]	....	....	....	.039	.098	552	555

* The dates which are starred are days on which the patient was vibrated.

[1] Patient was very sleepy during the course of the experiments and did not answer well.

[2] Experiments made in the afternoon.

[3] The patient had very little sleep during the previous night.

[4] These experiments were made August 26 after extra practice of two similar experiments each day for one week. See Table III.

at the beginning of the series, as compared with what it was found to be at the end, is very high and the pressure sense seems to be considerably dulled.[6] It is true that during the progress of the experiments the patient was gradually getting better, but precautions were taken at all times to determine whether or not the high determinations which were made were due to a dulling of the sensibility or to his slowness in responding. Often during the course of the experiments on any day a number of *Fehler Versuche* were made by holding the instrument either above the skin so that no touch was given or by pressing it down to a point where it seemed likely the stimulus would not be perceived and keeping it there for a few seconds. Both of these methods gave usually negative results. Occasionally there was what might be termed a premature reaction, *i. e.*, a response when he was not being stimulated, but with the other method response was not obtained until the pressure had been increased. It is, however, interesting to note that there is a decided improvement in the pressure sense. Whether or not this be due to an actual improvement in the pressure sense itself or be due to a lessening of the retardation cannot be definitely decided. We believe that the improvement is an actual sensory improvement (using in our present state of ignorance the term sensory to include the whole sensory apparatus, end organ to the brain). The results obtained when the second precautionary method was used indicate this, it seems to us, very clearly. Furthermore, we shall see in a comparison of the results on the vibrated and non-vibrated days (Table II) that on the vibrated days the improvement is much more marked. This would indicate that the extra stimulation which was given to the back and which probably had its effect

[6] Using a similar instrument and method, Griffing (On sensations from pressure and impact. Psychological Review Monograph Supplement, 1895, I, 1, p. 88.) found on two normal subjects an average pressure threshold of 2.3 gms. over an area of .9 sq. cm. If the pressure necessary to be perceived varies directly with the area of stimulation, we should expect a pressure of .012 gms. to be perceived when the area of the stimulating instrument is .4 sq. mm. It should be mentioned that other investigators found relatively higher thresholds than did Griffing, and still others found much lower. See table in Sherrington's article on Cutaneous Sensations in Schäfer's Text Book of Physiology, Vol. II, p. 927, and table in Landois' Physiology (trans. by Brubaker), 1904, p. 928.

upon the spinal cord helped to increase the irritability of some part of the nervous mechanism.

Similar results are found for pain threshold. Usually the statement is made that the pain appreciation in this class of patients is not diminished. This conclusion, however, has been drawn entirely from a few rough clinical tests such as pricking with a pin, although often it is admitted that these patients react very little to pin pricks. We have been unable to find any accurate determinations of the pain threshold in this class of patients to substantiate the general opinion. A reference to the table will show that the threshold at the beginning of the experiment was over 50 per cent higher than it was at the end of the series, and, moreover, it is particularly noticeable that the results of the first two weeks, July 10 to 21, are very much higher than the results obtained from August 8 to 19 after the patient had had a period of two weeks without experiments. If the lowered threshold was due to practice we should expect that a part of the practice effect would have disappeared during the two weeks' interval.

Similar precautions were taken in these experiments as were done in the touch threshold series, but even when the instrument was kept at a point of considerable pressure, the subject did not respond, although sufficient time was given for a retarded answer.[1]

The experiments on the accuracy of movement show practically nothing. The results are included here for their negative value, because they indicate that there is no disturbance of the "movement" sensations. There is no constant increase or de-

[1] This would indicate that at such times the threshold was even higher than we had determined since Griffing found that the pain threshold was a function of the time of stimulation as well as of the area and intensity. Op. cit., p. 80-83. Griffing found in 40 persons an average of 5100 grams for pain threshold when the area was 0.9 sq. cm. The results at the beginning of S's series are, therefore, much higher than the normal average and those at the end of the series, while they approach this average, are somewhat higher. It should be further noted that Griffing found (Op. cit., p. 53, note) that in some pain measurements "a number of experiments had been made on the hand before, and it seemed to have become less sensitive by about 2 K. than when it was first tested." This conclusion would indicate that any "practice effect" for pain threshold would be towards an increase rather than a decrease of the threshold.

crease in the average error from the first to the last of the series, nor does the constant error show any special tendency. If there was any disturbance of motor sensation it should show itself in an increase of the average error, but throughout the series the proportion of the daily average error to the total length of lines which were drawn is no greater than normal.

There is an increase in rapidity in tapping time from the first to the last weeks of the series, coincident with the gradual recovery of the patient. Part of this increase in speed must be considered as due to a practice effect, particularly during the first few days, July 6, 7, and 8. For reading 100 figures there is a considerable decrease in time, but here also some of the increased rapidity is undoubtedly due to practice.

In Table I notes have been made that the results obtained on July 14 and 18, and on August 10, are not strictly comparable with the results on the preceding and succeeding days. On July 14 the patient did not co-operate well. He seemed very sleepy, often indifferent, and sometimes unwilling to have the experiments made. Several times on that day the subject said that he felt the touch stimulus some time before he responded. In comparison with July 13 and 15, the results of this day show striking deviations in almost every kind of experiment.

Unfortunately, it was impossible to make the usual experiments on the morning of July 18, and the patient was tested late in the afternoon. So far as a general comparison is concerned the results cannot be used with any of the morning experiments, but they give a more exact measure to the commonly observed condition of afternoon improvement.

The effect of a restless night is indicated in the results of August 10. The averages, except for touch threshold on the hands and the pain threshold of both hands and back, do not indicate the great difference in the patient's feeling of well or ill-being. During the previous night the subject had slept very little, and in the morning became quite voluble, easy in manner, active, although subjectively he felt rather depressed. The condition of the subject or of the experimental conditions of these three days, we judge, are not sufficiently similar to warrant their grouping and averaging with the results on other days. In the

succeeding comparison of the daily results, therefore, these three days have been disregarded.

The patient, it has been mentioned, was vibrated on alternate days. The results both for the vibrated days and those for the non-vibrated days are given in Table I, but we have combined the results to determine any effect succeeding the mechanical stimulation.

The average time of tapping on the non-vibrated days (omitting July 18 and August 10) is found to be .212 sec. Should the first day be discarded also because of the patient's unfamiliarity with the methods, etc., the average is .211 sec. On the vibrated days (omitting July 14) the tapping time averages .199 sec.

The average results for the time of reading on the vibrated and non-vibrated days do not show any difference in time if the result of August 10 is omitted. The time measurements were made, however, roughly with the second hand of an ordinary watch and the error of recording from such an instrument is probably much greater than any time differences in the process of reading. A more accurate method might indicate some differences, but at present we can report only negative results.

In the experiments upon the accuracy of movement it has been mentioned above, no improvement was noted throughout the series. The comparison of the results on the days when the subject was vibrated with those on the non-vibrated days (omitting, of course, results of July 14 and 18 and August 10) give, respectively, average errors of 5.02 mm. and 4.79 mm. and constant errors of +0.83 mm. and +0.58 mm. The average relative amounts of the average errors compared to the total lengths of line were equal on the vibrated and non-vibrated days. It is interesting to note that the constant error averages greater on the vibrated days, there is a greater tendency to make each line somewhat longer than the preceding one. In experiments on normal subjects it has been found that when an individual is feeling particularly well, and there is a general feeling of *bien aise,* there is a tendency to a greater movement, and, as Münsterberg has shown, of an extensor type. On the days when the subject did not feel so well there was less tendency to overestimate movement and, in fact, a tendency towards a movement of a flexor type.

How much this factor is present in S.'s results we cannot say. It would be interesting to repeat these experiments if the patient should become "set up" or even maniacal. The results at present do not indicate any special change in one direction or other. It has been noted, however, that at no time during the series could the results be interpreted to indicate a lowering or a defect of the "motor" sensibility.

In Table II we find much more than an indication of the stimulating effect of the mechanical vibration. Both the touch and the pain threshold are lowered on the palms and on the back on

TABLE II.

AVERAGES OF PRESSURE AND PAIN THRESHOLDS DETERMINATIONS. SUBJECT S.

Results of experiments on July 14 and 18 and August 10 have been omitted. The numbers of days are given in parentheses. 76 pressure and 38 pain determinations on the hands, and 16 pressure and 8 pain determinations on the back each day.

	Pressure Threshold in grams.		Pain Threshold in grams.	
	Palms.	Back.	Palms.	Back.
Vibrated Days	.1245 (11)	.209 (10)	782.1 (11)	783.6 (10)
Non-Vibrated Days	.1398 (10)	.247 (9)	797.5 (10)	783.9 (9)

the vibrated days in comparison with the results on the non-vibrated days. For the touch threshold the improvement on the palms is over ten per cent and on the back over fifteen per cent. The improvement in the pain threshold is not so marked either on palms or back, and for the back the difference is too slight to be significant.

Taking the results of all the tests it is quite evident that the vibratory exercise has caused some change in the body, so that on these days the patient moved more quickly and his touch and pain feelings were not so dulled. The effect of the vibration is very largely stimulating to the tissues in the immediate neighborhood of the area vibrated and probably it has also considerable effect upon the structures adjacent. In this case it is probable

that the spinal cord and the spinal nerves were affected, and this would very naturally increase the irritability of these parts. With an increased irritability of the nerve elements we would get a decrease in the stimulation thresholds.

SERIES II.—In the second series of experiments both S. and Ev. were used. On S. the tests were made each day for a week, and on Ev. for four days. The experiments included (*a*) time of simple and choice reactions, (*b*) the rapidity of movement, (*c*) the time of reading, (*d*) the time of discrimination and movement.

Reaction times.—In these experiments the time for moving a finger of the right hand when a sound was heard gave the time for the simple reactions. For the choice reactions, the same finger reacted to the same sound, and a finger of the left hand to another, but lower, sound. The choice reaction times for the right hand have been the only ones considered, since they are strictly comparable to the simple reaction times. The time was measured by a Hipp chronoscope, and the results which are reported are given in thousandths of a second. With one exception (noted in the table), twenty-five of each kind of reaction were taken at each sitting. The figures in the tables are thousandths of a second.

Rapidity of movement.—The simple reaction time gives us data for the rapidity of movement, but in addition two other tests were made each day. One of these was the tapping experiment described in the previous series (p. 242). The other was the time for distributing some cards. In this test the subject was given a pack of 100 colored cards, each three inches square, which he was instructed to place in a stack, one at a time, at his maximum speed. The calculation of the tapping records was done in the same manner as for Series I. The total time for the distribution of the 100 cards are given in Tables III and IV. The average time for handling and stacking one card can easily be calculated by dividing the total time by 100.

Time of reading.—Pages of an unfamiliar book were given to the subjects with instructions to read as rapidly as possible, disregarding the sense, but reading every word. The matter selected was as free as possible from all difficult words, and persons of ordinary education could read everything understandingly, if it were required. The total time for reading such a page divided

by the number of words gave us the average time for reading one word. The figures in the tables refer to this result.

Time of discrimination and movement.—Here also two different kinds of experiments were made. The first of these was the distribution and discrimination of 100 colored cards. Ten cards, each of a different color, were arranged in a semicircle upon the table and the subject was given the well-shuffled pack of 100 cards,

TABLE III.

THE TIME OF CERTAIN MENTAL PROCESSES, AS INFLUENCED BY MUSCULAR EXERCISE. SUBJECT, S.

Exercise was taken on August 21, 23 and 25.

Day and Time.		Average simple reaction time. 25 experiments each session.	Average choice reaction time. 25 experiments each session.	Average tapping time. One tap.	Distributing 100 cards. One stack.	Discriminating and distributing 100 cards. Ten stacks.	Time for reading one word.	Marking 100 *e*'s.	
								Total time.	Number of *e*'s omitted.
				sec.	sec.	sec.	sec.	sec.	
A. 21, exerc.	8.30	325.6 (20)	450.9 (10)	.203	82	155	.372	170	15
	11.00	269.3	287.4	.176	56	146	.344	136	13
A. 22, rest.	8.30	220.6	274.3	.188	71	159	.358	143	10
	11.00	210.7	270.6	.191	57	135	.351	152	16
A. 23, exerc.	8.30	230.0	277.6	.196	67	140	.358	148	9
	11.00	220.7	256.7	.203	63	129	.341	162	13
A. 24, rest.	8.30	224.1	278.3	.176	64	135	.335	150	
	11.00	182.3	248.9	.182	67	121	.335	166	
A. 25, exerc.	8.30	198.1	232.6	.190	75	141	.348	158	6
	11.00	221.2	214.2	.195	68	128	.342	159	11
A. 26, rest.	8.30	218.4	237.3	.192	79	119	.340	136	10
	11.00	187.4	235.3	.194	80	118	.349	152	4

consisting of ten cards of each color represented on the table. He was told to distribute the cards according to the color as rapidly as possible. By subtracting the time necessary for placing the 100 cards in one stack we obtain the time necessary for discrimination and for association of the color with a certain position on the table. The second experiment of this general character was the determination of the time necessary to cross out 100 small *e*'s in a solid paragraph of printed matter. About a third of a

page was given to the subject with instructions to mark all the *e*'s as rapidly as possible. There were about 900 other letters in the paragraph. Each *e* missed by the subject was counted as an error in calculating the results.

The results of these experiments on S. are given in Table III and those on Ev. in Table IV.

It is evident that there is a gradual but not a regular day-to-day improvement in the result of S.'s experiments, just as was

TABLE IV.

TIME OF CERTAIN MENTAL PROCESSES, AS INFLUENCED BY MUSCULAR EXERCISE. SUBJECT EV.

Exercise was taken August 22 and 24.

Day and Time.		Average simple reaction. 25 experiments each session.	Average choice reaction. 25 experiments each session.	Average tapping time. One tap.	Distributing 100 cards. One pile.	Discriminating and distributing 100 cards. Ten piles.	Time for reading one word.	Marking 100 *e*'s. Total time.	Marking 100 *e*'s. Number of *e*'s omitted.
				sec.	sec.	sec.	sec.	sec.	
A. 21, rest.	9.00	292.2	378.8	.219	143	322	.361	164	10
	11.30	246.4	401.3	.233	161	394	.350	182	27
A. 22, exerc.	9.00	273.7	335.0	.240	118	339	.363	187	4
	11.30	236.5	367.8	.250	124	320	.362	177	22
A. 23, rest.	9.00	246.4	369.8	.248	188	349	.388	210	9
	11.30	253.9	403.7	.246	171	317	.349	175	14
A. 24, exerc.	9.00	264.4	353.4	.242	182	325	.375	171	16
	11.30	293.8	405.6	.288	130	339	.365	168	21

noted in Series I. When the results are grouped according to the effects of periods of exercise and of rest, some interesting facts are found. For S. there is a greater absolute lessening of the time for most of the experiments after the two hours' exercise, and with the exception of the simple reaction-time and of the time of discrimination and distribution of 100 cards there is a greater relative improvement.

The relative amounts of the average time necessary for the different experiments after the periods of exercise and rest as com-

pared with the average time before the exercise and rest are respectively as follows:

Simple reaction time	94.4%	and	87.6%
Choice reaction time	78.9%	"	95.9%
Tapping time	97.4%	"	102.0%
Distributing 100 cards	83.4%	"	95.2%
Discriminating and distributing 100 cards	92.4%	"	90.6%
Reading one word	88.9%	"	100.2%
Discriminating and marking 100 *e's*	96.0%	"	109.6%

After the exercise the subject reported much less depression of feeling although he said he was quite tired. Clinically, it was observed that his movements were much more free, and that he talked more easily and without any hesitancy. He took considerable interest and made many inquiries regarding the experiments. On the resting days this " freedom " was not so noticeable.

The anomalous reaction-times which were reported[1] in some earlier experiments on Ev. have also been found on August 25 with S. This would indicate that the condition which has previously been described at some length is more or less characteristic in this class of patients under certain conditions, as yet unknown.

After the exercise taken by Ev. on August 22 and 24, the patient complained that he was greatly fatigued, and not feeling so well as he had earlier in the morning. The comparison of results on the " resting " and " walking " days shows that there is less improvement when exercise was taken. Ev., it will be remembered, is 67 years old, and for two years has been very quiet, moving about little, and being in rather poor " condition " (to use the language of athletics). For such an elderly man the amount of exercise given him was sufficient to bring about a state of fatigue and to introduce the fatigue effect into the results after this exercise.

Various experiments have shown that exercise in moderate amounts is followed by an increase in efficiency and rapidity of mental work, and that fatiguing bodily work is succeeded by a decrease in quantity, quality, and rapidity of mental processes.

[1] Franz: Op. cit.

The two hours' exercise was sufficiently stimulating to S. who, previous to the experiments, had been accustomed to walk for a considerable distance each day, but the same amount of bodily work was fatiguing to Ev. For a period of two years, Ev. had not taken so much exercise in a week or more as he did on each of the exercise days of the experiment.

At present we are able to conclude from the foregoing results, although they are few in number, that moderate active exercises have a beneficial effect in the condition of retardation. Hoch's conclusion [9] that the practice effect is not carried over to the next day does not apply to the kinds of experiments which we have carried on. A glance at Tables III and IV of this article will show a gradual day-to-day increase in rapidity, and the earlier experiments on the reaction-times of Ev.[10] show a similar improvement. We cannot agree, therefore, with Hoch in considering the retardation largely a difficulty in initiating a movement.

SUMMARY.—The results of these studies may be summed up as follows:

1. The thresholds of pain and pressure appreciation are higher than normal in a case of retardation.

2. There is a daily improvement in the pressure and pain sensibility coincident with the lessening of the retardation and the depression.

3. The accuracy of movement is not affected by depression and retardation.

4. The speed of movement is lessened in the retarded condition, but it is gradually increased during the period of recovery.

5. Mechanical vibration increases the rapidity of movement, and lowers the pain and the pressure thresholds.

6. The speed of mental processes is increased with improvement in the mental condition of retardation.

7. After moderate exercise there is more improvement than after a similar resting period.

CONCLUSIONS.—While the experiments with which we have attempted to determine the effects of active and passive exercise in cases of depression with retardation were made upon only one

[9] Op. cit.
[10] Franz: Op. cit.

patient in Series I and upon two patients in Series II, we feel that the results obtained are of some practical significance with reference to suggestions for treatment.

Owing to the necessary inaccuracy of purely clinical observation, and the misleading statements of patients who have a morbid aversion for any kind of effort, it seems trite to say that more accurate methods should be employed for the determination of the effects of the various methods of treatment. Some alienists advocate a "rest cure" for their patients, while others follow a régime which includes a varying amount of passive and active exercise. In neither case is the value of the treatment demonstrable by the present clinical methods. Some patients improve rapidly and others slowly, so that one never knows whether to attribute the rate of recovery to the natural resistance and the natural recuperative powers of the individual or to the effects of the treatment. It is obvious that the patient is incapable of deciding what is best for him, and equally obvious that the clinician must often depend upon the unreliable data gained by the ordinary clinical tests. The more accurate methods available in the laboratory are, therefore, of considerable importance in that they offer more tangible evidence of the values of the various curative methods. Moreover, it reassures the patient in that he believes something is being done for him. In the experiments just described, S., for example, spoke of their beneficial effect and found much comfort in an assurance of his improvement, which he knew to be backed up by data obtained in the laboratory. In a more extended series of experiments made by one of us, several other patients reported their belief in the benefit of the tests to them.

The results obtained from Ev. and from S. furnish examples of the practical nature of the laboratory methods. While Ev. is an elderly man, we felt that the two hours' walk intervening between his series of experiments might not be excessive. As is shown in Table IV the patient's complaint of great fatigue was not entirely due to his disinclination to taking exercise. The data obtained show an unmistakable fatigue effect. In the case of S., a comparatively young man, there was a consistent abatement of the retardation symptoms after the two hours' exercise, while the same amounts of rest affected either only slightly or not at all

these symptoms. The twenty-five days of alternate rest and vibration unmistakably point to the same conclusion.

Excluding these cases in whom there is a considerable degree of physical depravity incident to old age, somatic complications, or poor nourishment, we believe that there remains a large class of patients whose feeling of inadequacy, retardation, and mental depression are indications for exercise, both passive and active. The amounts of this exercise, we think, should be determined for the individual cases by methods more accurate than the usual clinical observations.