

## TENTATIVE NORMS IN THE RATIONAL LEARNING TEST<sup>1</sup>

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The present test was devised by the writer as a special study in learning, primarily. It was soon found that it is a rather good means of determining one's intellectual ability and also that it has useful diagnostic values as to certain kinds of traits, particularly degree of rational organization and of subjectivity of mind.<sup>2</sup> "The reaction required of the subject is to associate in a random order the numbers 1 to 10, inclusive, with the first ten letters of the alphabet. This is to be done by means of a series of guesses the range of which may be greatly limited by the use of a rational organization of the situation. Each subject completes the learning at a single practice period, varying in length inversely with the subject's ability, roughly speaking. As will be seen, the subject is forced to react to a changing situation, each response making it different to a slight degree by limiting the range of probability." The test at present can be used only as an individual test, but in this use it has some advantages over other individual tests: it is easy to give to a subject, the methods of presentation of the situation and of scoring results being objective. No printed forms other than a paragraph of instructions are necessary; the tester writes on the test sheet the necessary headings, the name of the subject, date, time of beginning, etc, while the subject reads the instructions. The time of beginning is the time at which the tester first calls out "A;" the subject is allowed as much time to read the instructions as is necessary, and should be encouraged to re-read at least once. Finally it is possible to increase the difficulty of the test to any desired point, by the addition of letters.

<sup>1</sup> Read before the Southern Society for Philosophy and Psychology in the New Orleans meeting, April 23, 1920.

<sup>2</sup> See Experiments in Rational Learning, *Psychol. Rev.*, 1918, 25, 443-467. A report on correlations with work in psychology will appear in the March, 1920, number of the *Journal of Educational Psychology*. A modified form of the experiment has been used by Sunne, *Psychol. Bull.*, 1919, 16, 262-267

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The norms in this report were obtained with the form of the test shown in Table I, ten letters being used, numbered as there shown. More detailed instructions as to the giving of the test are to be found in the first reference in note 2.

TABLE I  
Name, L. D    Time beginning, 9:40; time ending 9:52

Letters. Numbers	A 9	B 6	C 2	D 10	E 8	F 1	G 5	H 4	I 7	J 3	Errors			
											Unclassified	Log x	Per. *	Total
First series.	3 5 1 2 9	8 7 10 3 1 6	5 3 1 7 10 9x 4 2	5 7 10	8	7 5 4 1	10x 3 5	10x 3 1x 7 6x 9x 2x 7* 9x* 2x* 4	5x 3 7	3	35	10	3	48
Second series	2 6 8 4 1 9	6	10 9x 2	9x 7 10	7 9x 8	7 5 3 9x 1	7 3 5	5x 9x 7 5x* 7* 9x* 10x 6x 9x* 6x* 4	7	9x 10x 6x 8x 2x 1x 3	33	18	5	56
Third series	8 6 9	2 4 8 10 1 7 8* 6	10 1 8 6x 3 7 5 8* 6x 5* 4 10* 2	10	7 5 3 1 8	1	7 3 4 2x 5	4	3 7	3	30	3	5	38
Fourth series	9	6	2	10	8	1	5	4	7	3	0	0	0	0
Fifth series	9	6	1 8 2	10	8	1	5	4	7	3	2	0	0	2
Sixth and seventh series correct														
U.C Errors	11	12	23	4	6	7	8	20	3	6	100			
x Errors (log.)	0	0	4	1	1	1	2	15	1	6		31		
* Errors (per.)	0	1	4	0	0	0	0	8	0	0			13	
Totals	11	13	31	5	7	8	10	43	4	12				144

Score: 12 min , 7 repetitions; 144 total errors.

The following typewritten instructions are given to the subject to read.

The letters A, B, C, D, E, F, G, H, I and J are numbered in a random order from 1 to 10. I call out the letters in their order and you are to guess numbers for each letter till you get the correct one, when I say "right." Then I call out the next letter; and so on. This continues till you get each number right, the first guess, twice in succession through the series from A to J. Then you are through. You must ask no questions, but are to use all the mental powers at your command in order to complete the learning as soon as possible. You will be ranked by (1) the total time you take, (2) the number of errors, or wrong guesses you make (every number you speak being a guess), and (3) the number of repetitions from A to J that you require for the learning. Re-read these instructions carefully if necessary to understand what you are to do. The meaning will be clearer as we go on with the experiment.

Caution. When you get through with this experiment please do not say anything about it to others who may take it, as doing so might make it easier for them than for you.

When the subject is ready to start, the tester notes down the exact time in minutes and calls out "A." The subject usually stops after the first guess, and has to be told to go on till he gets the right number. In time the tester does not say "right" when the correct number is given, but will find it best just to call out the next letter. Every guess the subject clearly speaks out is recorded in a column just under the letter. It is common for subjects to reject certain guesses just after they have been made. This rejection should be noted by some symbol, but the number should be retained. People so often speak, and think afterwards! When the test is completed the time must be recorded immediately. Errors are then marked and counted, and the individual record will have the form shown in Table I. Logical errors are errors of guessing a number that has already been used for an earlier letter in the series, marked by an  $x$  in the record; and perseverative errors, marked in the figure by an asterisk, are errors of repeating a guess while reacting to any given letter. In indicating errors on the original record, logical errors may be checked and perseverative errors enclosed in a circle.

In addition to these quantitative records, it is well to note down, just after each test is completed, anything striking in the subject's method of going at the solution of the problem.

In this test several kinds of results are obtained, any one of which may prove to have diagnostic values, either of general intelligence as we now vaguely conceive it or of other rather general traits related in important ways to success in certain of the larger divisions of human activity. One does not, for instance, think of salesmen as being highly subjective-minded and over-conscientious. We have not attempted, therefore, to combine the scores in time, number of repetitions, and errors of the various kinds mentioned, into a single scale. It has been found, moreover, that some of these scores are far from being distributed about a mean in the form of the normal curve. This lack of so-called normality in distribution is particularly evident in the perseverative errors, and to a considerable extent also in the number of repetitions. In the former case the mode is at zero errors, and in the latter, at six repetitions, the smallest number of repetitions made by any subject. Neither time nor error data of the three other kinds shown in the table—*uc.*, *log.*, and total errors—approximate closely to the normal distribution. The reasons for this are to be sought partly, at least, both in the unfair sampling of college students as representative of the average adult mind (as is shown by a study of the regression lines, in the second reference indicated in note 2) and in the mental inequality of the steps of our scales. Illustrating this mental inequality of steps, we may say that the difference between a score of 36 and 86 total errors is greater than that between a score of 383 and 433, though the absolute difference in both cases is fifty.

To get a table of norms that presents all the possibly significant kinds of data, and also that does not rest its validity on an assumption of normal distribution, we have constructed a percentile table of the different kinds of scores shown in Table II. These norms are based on the records of 113 college students, mostly sophomores in psychology in the writer's classes. Eighty-one of the subjects were University of Minnesota students in the College of Science, Literature and the Arts, and were tested in the spring of 1918; and thirty-two were Peabody students, tested in the latter part of the winter quarter, 1920. The tests were given by the writer and an advanced student in the former case, and extended over a period of a week; and in the latter case by the writer and three students, all during the same day. Precautions were taken against

TABLE II  
PERCENTILE NORMS IN RATIONAL LEARNING—ADULTS  
(Based on 113 Cases)

Per- centile	Min- utes	Repe- titions	Errors			
			Uc.	Log.	Persev.	Total
100	6	6	34	2	0	36
90	10.3	7 1	65	15	8	86
80	11 6	8 8	81	22	2 0	111
75	12 3	9.5	90	26	2 7	117
70	13 0	10 2	95	30	3 4	129
65	14 3	10 8	103	34	4 5	146
60	14.9	11 3	117	41	7 3	172
55	15 5	11 8	131	43	8 5	185
50	16 1	12 4	146	51	9 4	204
45	17 7	13 0	160	55	10 2	223
40	19.5	13 5	170	60	11 0	235
35	20.5	14.3	194	67	12.5	277
30	21 8	15 4	210	82	14.8	310
25	23 4	17 1	225	95	17 9	331
20	26 5	17 8	256	102	20 7	383
10	34 7	20 7	356	148	30 9	523
0	60 0	33 0	780	335	61 0	1160

coaching, and there was no evidence whatever that any student coming to take the test knew anything of importance about it before seeing the instructions. Not all the students in the classes from which these subjects were taken were tested, but only those who could arrange favorable hours. Of the Minnesota classes—three sections—70 per cent, and of the Peabody classes only 60 per cent, were tested. There seems, however, to be no evidence of unfair sampling. Illness in the latter case prevented the testing of all the students. There is evidence that the Peabody group is composed of a more highly selected body of students than is the Minnesota group, for upon averaging the percentiles in time, repetition, and total error scores by the two groups, we found that the Minnesota median is passed by about 65 per cent of the Peabody group. The norms of the combined groups are probably roughly representative of college students. It is evident, of course, that

the percentiles become less reliable as they are further removed from the median, the 50 percentile.

Correlations of results of the Rational Learning Test with scores in psychology examinations, and correlations of ranks in this test with ranks in the Otis Group Intelligence Scale and with ranks in the Army Alpha test, though yet based on an insufficient number of cases to have a high degree of reliability, indicate that the best measure of the subject's general intelligence is that which takes note of all the criteria mentioned in the instruction sheet—time, number of repetitions, and number of errors. But even then several methods may be used, each giving relatively different weight to these various factors and even to the different classes of errors described. For instance, we may find the percentile of the number of minutes, of the number of repetitions, and of the total errors, and average these; or we may take *twice* the percentile of the number of total errors and divide the sum by four, thus giving double weight to the errors made by the subject as against the time taken and the number of repetitions. Any other weighting of these three factors is, of course, possible. In considering errors, moreover, we may simply consider the unclassified errors, or we may give extra penalty for logical and perseverative errors, according to any one of several means conceivable. Each of these methods will give ratings of subjects slightly different from those derived by the others. But the differences are, after all, not as great as might be expected; for more time also means more errors and more repetitions, as a rule; on the whole, high ranking on any one of the criteria means high ranking on the others. The correlation between rankings by unclassified errors and total errors is but very slightly below 100. I got .99 with 81 subjects, the total error score being slightly better than the unclassified error score. The correlation is also very high between ratings in the Rational Learning Test when the total errors are counted on the one hand, and when total errors, minutes, and repetitions are considered on the other. In this case with twenty-nine subjects recently tested I got a correlation of .88, the better rating being obtained by the three-criteria method. While it is hardly possible at present to arrive at even a practical final judgment as to which criteria in the Rational Learning Test are most serviceable for the measurement of general intelligence, the best method appears to be simply to get the average of the percentiles of total errors, number of minutes, and number of repetitions. This measure is easily

derived by the use of our percentile table. For example, the record of L. D. in Table I shows 144 total errors, 12 minutes, and 7 repetitions. The corresponding percentiles, as found in Table II, are: 65, 75, and 90, respectively. We simply take the approximate percentiles, the nearest multiple of five, as the tables are not yet accurately enough standardized to warrant taking the extra time for finding the exact percentile. Even to take the nearest percentile shown in the table is justifiable by the fact that the extremes—above 80 and below 20—are less accurate than are those nearer the median. R. L.'s percentile rank is therefore  $\frac{65 + 75 + 90}{3} = 77$ . The general equation is

$$PR = \frac{P_{te} + P_m + P_r}{3}$$

PR is for percentile rank, P, percentile; and the small letters in the numerator, *te*, *m*, and *r*, are for total errors, minutes, and repetitions, respectively.

But in individual diagnosis it is not well to stop with one's *general* rating. We see that R. L. is ranked in the upper 25 per cent of college students, but in unclassified errors he surpassed only 65 per cent of college students, in logical error and perseverative error scores, 70 and 35, respectively. He is considerably below the median in perseverative errors. This probably indicates a subjectivity of mind, further data regarding which should be sought in the notes on his general behavior during the test, and in the detailed record of his responses, as shown in Table I. He collected himself very readily after confusions in the third series, and in the fourth made a perfect record, though two errors were again made in the fifth series. Notwithstanding confusions here and there, probably due to subjectivity of mind, R. L. seems to fall with the more logical, as opposed to the trial-and-error type of individuals.

The rank of a group can be obtained by finding the median percentile rank (PR) of all the members, and the various methods of comparing groups may be employed if the PR of each individual is taken as his score.

Other forms of the Rational Learning Test with ten letters may be obtained by making up a different order of the numbering of the letters, but in doing this care should be taken not to follow any subjective order that may be of aid to the subject. The norms here given apply only to the numbering shown in Table I, though they may be found to be fairly accurate for other forms. We have found no trouble with coaching thus far, but intend to standardize the test in at least

two forms for different ages. This will not only aid in precautions against coaching but will add materially to the value of the test for various purposes. It appears desirable to use fewer letters in the test for children of the grades, as the present form is too hard for them. The median time for adults on the present test is slightly over sixteen minutes, and the determination of the subject's percentile rank after the test requires but a very short time.

If the test proves to be sufficiently worth while to warrant finding the subject's IQ, as used by Terman, this measure can readily be determined from the use of a table such as is given in the Otis' Group Intelligence Scale, *Manual of Instructions*. One must exercise caution in attempting to work out IQ's from standards derived from tests of college students, who compose a rather highly selected group.

The Rational Learning Test has been used in modified forms by Sunne, to whose report we have already referred, and by B. F. Haught. Sunne had twelve keys numbered in a random order, and so arranged that when key 1 was pushed a lamp would light; when this had been located, key 2 would next light the lamp; and so on. In this form spatial and other factors enter making results hardly comparable with those which we have presented here. Mr. Haught's method is to have ten keys under each of the ten letters we have used, one key under each letter being connected with a battery so as to ring a bell if pushed. No results by this method have yet been published. It is desirable in any such scheme as this to have some sort of self-recording apparatus; and it seems to be within the range of probability to have devised in time a machine with which the subject can be left wholly alone, and which will record in a convenient form, and in order of occurrence, all his significant responses. In the making of such a contrivance careful consideration should be given to the possible operation of spatial factors, as opportunity for space habits will reduce the difficulty of the problem for most persons. The present form of the experiment, however, whether used as a test or as a study of a higher form of learning, is not only convenient and highly objective in procedure so far as a study of the higher thought processes is concerned, but it also eliminates rather successfully the influence of spatial habits.