A STUDY OF CERTAIN QUALITATIVE ASPECTS OF PROBLEM SOLVING BEHAVIOUR IN SENILE DEMENTIA PATIENTS.

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1. INTRODUCTION.

RECENT psychological investigations have left little doubt that considerable mental deterioration takes place with advancing age. The work of the United States Army Psychologists in the last war (22), of Beeson (1), Jones and Conrad (10), Weisenburg, Roe and McBride (21), Sorensen (18), Miles (11, 12, 13, 14), Ruch (17), Thorndike (19), Wechsler (20), Gilbert (7), Cleveland and Dysinger (3) and others makes it apparent that not only do the various mental abilities decline with age, but also that they decline at different rates.

In the research work mentioned above two points have not received as much consideration as they would appear to deserve. In the first place it seems reasonable to assume from the differential decline of ability that the way in which these abilities are organized in the mind may be profoundly changed in old age. This view is supported by certain data reported elsewhere (6). In the second place it seems possible that certain qualitative changes may take place with regard to any one of the abilities concerned. Piaget has shown reason to believe that such qualitative changes take place in the *growth* of intelligence; it would seem at least possible that similar qualitative changes may take place in the *decline* of intelligence.

The question of qualitative differences in problem solving has been dealt with most frequently in connection with schizophrenia and organic brain lesions. Reference may be made, for instance, to the work of Goldstein on *abstract* and *concrete* behaviour (8), and Cameron on regression in schizophrenic thinking (2). In his work Cameron touches incidentally on the problem of qualitative changes in the thinking of senile dementia patients, and although no direct conclusions are formulated, his results appear to be in line with those reported in this paper.

While these investigators used sorting tests of one kind or another, such as the Vigotsky Blocks, a standard intelligence test was used in this investigation. This well standardized perceptual problem-solving test was given to over 100 cases of senile dementia, and the scores, reliabilities, errors and various factors determining success or failure on the test items were analysed and compared with similar data from a normal adult sample and a group of children whose average performance was closely similar to that of the seniles.

2. EXPERIMENT.

(a) *Population.*—The population used in this experiment consisted of 100 male senile dementia patients at the Tooting Bec Hospital. A wide variety of professions was represented in the population used: roughly 20 per cent. had been labourers, handymen, carmen and unskilled factory workers, while another 20 per cent. had been highly skilled workers (instrument-makers, engravers, compositors, etc.), had been in business for themselves or had managed shops for others; the

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remainder were either unclassifiable, or had been employed in jobs intermediate between the other two groups. The average age was 73, with a S.D. of 6·5.

(b) *Test.*—The test used was the Progressive Matrices Test in its individual board form, as described by Raven (16, p. 12). In this form the subject is given 24 separate perceptually presented problems, divided into two sets, " A " and " B," each containing 12 problems. Each problem consists of a design or " matrix " from which part has been removed. Six alternative solutions are presented at the foot of the board; the testee has to examine the matrix, and decide which of the pieces given below is the correct one to complete the matrix. The designs are printed in colour and affixed to thick pieces of cardboard so that they can be readily manipulated, and the testee has a chance of seeing how well his proposed solution fits in with the total design. Often several solutions are tried out and rejected before the final acceptance of one.

(c) *Administration.*—The test was given to 100 subjects, and repeated after an interval of approximately three months on 84 (the others being no longer available). As the dullest subjects were very dull indeed it was necessary to make the instructions as simple as possible, and therefore the problems contained in Set " A " were presented as a game requiring *matching*, and the problems in Set " B " as requiring *completing the pattern*. In no case was an error pointed out, but the subjects were praised after each problem regardless of success.

3. Results.

(a) *Scores.*—The average score of the 100 patients tested was 14·5. The average score of normal adult subjects on these 24 problems is 20·7 (9). Thus the seniles solve correctly on the average 6·2 problems less than the normals. By means of Raven's Conversion Tables it is possible to transform these scores into percentiles. When this is done it is found that as compared with the average score of the normals, which is, of course, at the fiftieth percentile, that of the seniles is well below the fifth percentile; thus, on the average, their performance is equal to that of the lowest 3 or 4 per cent. of the normal adult population.

As mentioned above, only 84 patients repeated the test. On the first performance their average score was 14·7 ± 2·9 S.D. On the second performance their average score was 15·1 ± 3·1 S.D. The lowest score was 6, and the highest 20. Even the highest score was, therefore, below the average score for a normal adult population.

In standardizing the Matrix Raven used 26 problems in Sets " A " and " B," 20 of which were identical with those used in the present test. On these 20 problems the average adult score is 17·5; the average score for children of ages 8 ± 1 is 13·4; and for the senile patients it is 12·6. Thus their performance is roughly on a level with 8-year-old children.

Apart from comparing the scores of our group with normal adults and with children, it is possible to compare them with those reported on two psychotic groups, manic-depressive and schizophrenics (4). The relevant data are set out in Table I.

Table I.

	Set "A."	Set " B."	Total.
Manic depressive	9·2	6·7	15·9
Schizophrenics	9·7	6·1	15·8
Seniles (average)	9·4	5·5	14·9

In Set " A," the simpler of the two sets, the seniles achieve the same average score as the two other psychotic groups, but they are notably worse in the more difficult Set " B "—a result very much in line with expectation.

(b) *Order of difficulty.*—In Fig. 1 are shown the comparative orders of difficulty for 2,790 normal adults, 104 children of ages 8 ± 1, and the 100 senile dementia patients. The tests are arranged in ascending order of difficulty for the normal subjects.

It will be apparent that despite slight differences the order of difficulty is very similar for these three types of subjects. Rank correlation coefficients were calculated between the three orders of difficulty; these average + 0·95.

The larger differences as between normals and seniles are A5, B2, B8, A12 and

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B12, with the interesting point in addition that the seniles find B10 somewhat easier than either B11 or B12, neither of which in any case was solved correctly except by chance, while in a few cases B10 was understood and even put into words.

The larger differences as between the 8-year-old children and the seniles are A5, B2, B8 and B4. B10 is for the children, as for the seniles, considerably less difficult than B11 or B12. At the end of Set B both children and seniles fall off.

(c) *Reliability*.—The test-retest correlation for the 84 patients who repeated the test was 0·49 ± 0·08.

Raven (15), using the board form of the test but including 26 problems instead of

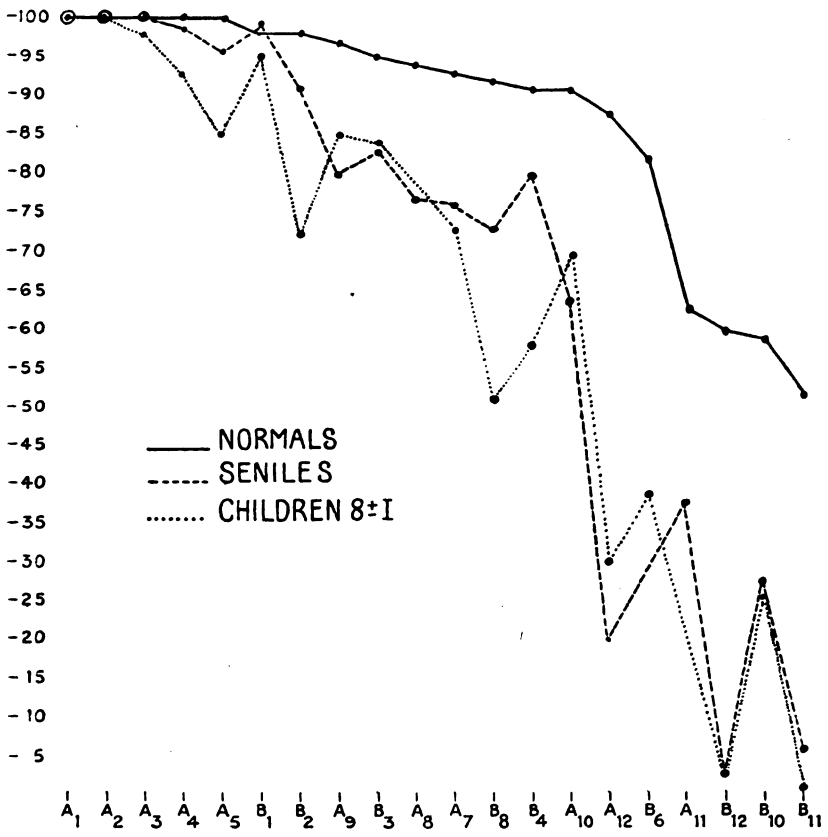

FIG. 1.—Percentage of three groups of subjects passing 20 items of the Matrix Test, arranged in order of difficulty for normal group.

24, retested 56 children between the ages of 5 and 9, and obtained a reliability coefficient of 0·86 ± 0·03. The average score of the 26 problems at the first testing was 14·5 and at the second testing 16·5, with S.D. 4·4 and 4·8 respectively.

The average scores of the seniles were similar, 14·7 and 15·1 for the first and second testings respectively, but with S.Ds. much lower, namely, 2·9 and 3·1. Direct comparison of the reliabilities, therefore, does not give a fair indication of the comparative accuracy with which these two groups of subjects are tested by the Matrix. The age range from 5 to 9 covers a period of great mental development, while the senile patients were all old and in nearly every case suffering from exaggerated senility, hence our population is much less heterogeneous than the children.

It is possible to estimate the reliability which would have resulted if 60 problems could have been used (as in the whole Matrix) instead of only 24 problems. Using the Spearman-Brown prophecy formula the corrected reliability would be 0·706. This is not very much below the reliability found for normal subjects when the

whole Matrix is used, and this agrees well with H. J. Eysenck's finding that neurotics are less, but not *much* less, reliably tested by the Matrix than are normals. He found test-retest reliabilities of 0·87 for normals and 0·81 for neurotics (5).

(d) *Analysis of errors:* (i) *Comparison with normals.*—Halstead (9) gives the most frequent errors made by 2,790 normal subjects, and I am indebted to him for his kindness in providing me with the exact number of subjects selecting each of the six possible blocks for the tests in sets " A " and " B."

As has been stated previously in Section (b), the *order of difficulty* for normals and seniles shows only slight disparity; what is of interest here is to compare the *type of error* the two groups make. Accordingly, in the following table the most frequent error made by the normal subjects is shown for each problem, together with the percentage of *those making an error on the particular problem* who solve it incorrectly in this way; the most frequent error made by the senile subjects is similarly shown, with the percentage of seniles making an error on the problem who solve it incorrectly in the way indicated. In three cases two designs were chosen incorrectly with the same frequency, and both block numbers are given.

TABLE II.

	Most frequent error made by normals.	Percentage of errors accounted for.	Most frequent error made by seniles.	Percentage of errors accounted for.
A 1	—	—	—	—
2	—	—	—	—
3	(2) (3)	50 50	(3) (4)	50 50
4	(3)	67	(3)	86
5	(2)	43	(3)	33
6	(2)	37	(1)	50
7	(4)	64	(2)	48
8	(6)	48	(6)	42
9	(5)	61	(5) (6)	40 40
10	(6)	56	(6)	46
11	(1)	43	(6)	45
12	(6)	52	(2)	41
		—		—
Average per cent. making most frequent error		52		48
		—		—
B 1	(1)	57	(6)	50
2	(2)	46	(2)	60
3	(2)	70	(2)	81
4	(4)	74	(4)	71
5	(5)	76	(5)	63
6	(2)	78	(2)	36
7	(6)	48	(2)	44
8	(2)	44	(2)	53
9	(1)	62	(1)	76
10	(1)	41	(1)	50
11	(3)	38	(3)	56
12	(2)	39	(2)	66
		—		—
Average per cent. making most frequent error		56		59
		—		—

For the 22 problems on which errors were made, the most frequent error is identical in 15 cases. Also, the percentage of each group who choose the most popular error is very similar; roughly just over one-half of the errors of each group agree with the most frequent of that group.

From the high amount of agreement between the groups on the incorrect block chosen it is not to be expected that any important findings will emerge showing fundamentally different mental processes at work which influence the senile patients in solving this type of test. The first disagreement comes in A5, where the seniles

select block (3), which is a single design of the correct pattern instead of the all-over design; the normals, on the other hand, pick block (2), which is an all-over design but contains no element of the correct pattern.

In A6 the disagreement is far from great: 37 per cent. of the normals who make a mistake on this one select block (2), and actually a higher percentage of the seniles chose that block as well, namely, 38 per cent. However, 50 per cent. of the seniles pick block (1), whereas it is chosen by only 18 per cent. of the normals.

A rather larger difference is apparent in A7, 48 per cent. of the seniles selecting block (2) and only 15 per cent. of the normals; while block (4) is favoured by 64 per cent. of the normals and 26 per cent. of the seniles.

The next discrepancy is in A11, where 43 per cent. of the normals but only 19 per cent. of the seniles chose block (1); and 45 per cent. of the seniles and 34 per cent. of the normals pick block (6).

The percentages for A12 are 52 per cent. of the normals, and 36 per cent. of the seniles select block (6), while 41 per cent. of the seniles and 15 per cent. of the normals prefer block (2).

In Set "B" there are only two cases of disagreement on the favourite error, namely, B1 and B7. So far as B1 is concerned, little weight can be given to the disagreement, as in all only 2 per cent. of the normals and 4 per cent. of the seniles made an error in the solution. In B7 48 per cent. of the normals select block (6) and only 6 per cent. of the seniles prefer it; 44 per cent. of the seniles and 17 per cent. of the normals choose block (2). This is, perhaps, the most interesting disagreement, with the seniles' choice being straight matching of the design above, whereas the normals' consists in realizing at least that the block to be supplied must in some way be similar to the odd one of the three patterns given.

Especially when it is recalled that the normals did the Matrix test as a group test, whereas the seniles were given the individual board form, it would appear that no outstanding differences appear in the type of error made. As the next section will indicate, it seems to be the position of the blocks rather than the particular design of them—except, of course, the *correct* design—which influences both types of subjects in selecting them.

(ii) *Importance of position of block.*—For those not familiar with the lay-out of the test items, it may help to indicate the general picture of each test as presented to the subject. He has at the top of the board (or page, as the case may be) an incomplete pattern with a space left blank to be filled in from the blocks shown at the foot. These are numbered in the case of the group test, and the same numbering was used in recording the seniles' choice on the individual board test. The position of the different numbers is as follows:

(1) (2) (3)
(4) (5) (6)

From watching the seniles attack the test, it appeared fairly obvious that certain positions of the blocks were more favoured by them than were others. Table III gives the percentage of errors in which each position was used, and also the same information with regard to the errors of normals.

TABLE III.

Seniles: *Percentage of Errors in which each Number was Used.*

	(1)	(2)	(3)	(4)	(5)	(6)
Set "A" .	20	22	8	11	6	33
Set "B" .	22	36	15	9	9	9
Average . .	21	29	11·5	10	7·5	21

Normals: *Percentage of Errors in which each Number was Used.*

	(1)	(2)	(3)	(4)	(5)	(6)
Set "A" .	30	9	3	18	4	36
Set "B" .	23	30	14	7	13	13
Average .	26·5	19·5	8·5	12·5	8·5	24·5

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Spearman's Rank Coefficient of Correlation between these two averages is 0·71, and as can be seen by inspection, the only large difference appears in the case of position (2), which is considerably more popular with the seniles than with the normals.

(iii) *Errors due to "matching."*—Commencing with problem B4, a marked tendency was observed for the subjects to "match" either the design above the blank space or the design to the left of it. It is interesting to find that the same tendency was evident in the normals. In the case of B8 the correct solution is given by matching the design above, so that test is not included in the summary below in Table IV, which indicates the relative strength of these two sources of error.

TABLE IV

	Percentage of errors due to matching design above.		Percentage of errors due to matching design to left.		Percentage of errors due to one or other of these.	
	Normals.	Seniles.	Normals.	Seniles.	Normals.	Seniles.
B4	74	71	15	21	89	92
B5	76	63	11	26	87	89
B6	78	36	5	25	83	61
B7	17	44	27	21	44	65
B9	62	76	33	15	95	91
B10	41	50	37	34	78	84
B11	38	56	32	33	70	89
B12	39	66	23	12	62	78
Approximate averages	53	58	23	23	76	81

Thus, 81 per cent. of the errors made by the seniles are accountable for by either of these two processes, and in the case of the normals only a slightly lower percentage.

(iv) *Error on same test in repetition: Identical Errors.*—The Matrix Test was given to 84 of the senile patients for the second time about three months later, the method and encouragement being the same as before, and care being taken also to see that the test was given to each patient at the same time of the day as on the first occasion.

On the first testing these 84 subjects made 227 errors altogether in Set "A," or 22·5 per cent. error; on the repetition they made 203 errors, or 20·1 per cent. On Set "B" there was a similar slight improvement on the repetition: 552 errors the first time, 540 the second, or 54·7 per cent. and 53·6 per cent. error respectively.

The total errors on the two Sets, therefore, decreased on the second giving from 779 to 743, or a decrease from 38·6 per cent. to 36·9 per cent.

Of the 430 errors made in Set "A" on the two trials, 168, or 39 per cent., were on different items, i.e. the subject solved an item correctly in one case and incorrectly in the other. 61 per cent. of the errors were made on the same items, i.e. the subject gave a wrong solution both times. 28 per cent. of the total errors were identical both times, i.e. the *same* incorrect solution was given both times. Of the errors made on the same items, approximately 46 per cent. were identical both times.

In Set "B" there was a total of 1,092 errors made on the two trials, of which 212, or 19 per cent., were on different items and 81 per cent. on the same items. Here 45 per cent. of the total errors were identical both times, and 56 per cent. of the errors made on the same items were identical both times.

The figures for the two sets combined show that 25 per cent. of the errors were on different items, 75 per cent. on the same, with 40 per cent. of the total errors being identical both times. Approximately 54 per cent. of the errors on the same items are identical errors.

This last percentage gives a good indication of the large element of chance error entering into the solution of this type of problem, at least for these senile patients. As the improvement on the repetition is comparatively slight, the figure of 25 per cent. of the total errors being on different items, with the subject's solution being in one case right and in the other wrong, also suggests a high degree

of unreliability, which is, of course, borne out by the rather low reliability coefficient mentioned earlier of 0·49.

(e) *Blocks tried out and rejected : perseveration.*—In the preceding subsection the blocks selected incorrectly were discussed ; in this subsection the blocks picked up but finally rejected as unsuitable are analysed.

The 100 patients on their first testing tried out and rejected a total of 830 blocks, 491 in Set " A " and 339 in Set " B." In other words, on the average each patient picked up and rejected 8 blocks during the solution of the 24 problems. Record was kept of only those blocks actually picked up. Many of the subjects would place their hand on a block, but discover it unsuitable before actually moving it, and this type of " mental " trying-out was not scored.

The blocks involved in try-outs are shown in the following table :

TABLE V.

	(1)	(2)	(3)	(4)	(5)	(6)
Set " A " . .	72	61	89	86	48	135
Set " B " . .	57	94	38	45	44	61
Total for each block position	129	155	127	131	92	196

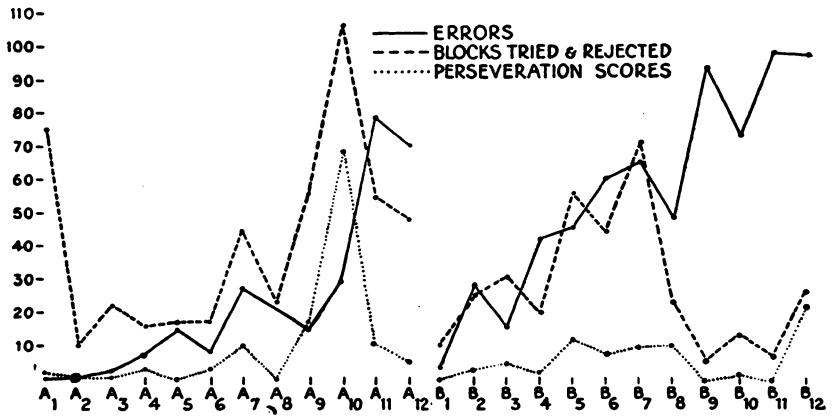

FIG. 2.—Scores of senile dementia patients on Sets " A " and " B " of the Individual Matrix Test.

It is interesting to compare this table with Table III, which shows the percentage of errors in which the different block positions were involved. In both cases position (2) is popular, but here it yields first place to position (6), which lay immediately by the subject's right hand and so was the easiest to pick up and try out, on the offchance that it might be the correct one. As before, position (5) is least popular.

It was noted that some of the senile patients would pick up a block, try it in the matrix, then decide it was incorrect and replace it in its position at the foot of the board. (This replacing was carefully insisted upon.) Then, either immediately, or after subsequent trials and rejections of other blocks, he would again try-out the same block, being in most cases completely oblivious of the fact he had already seen it in position in the matrix and not liked it. As a few subjects repeated the tryout of the same block not once but several times, the following method of scoring was used to weight the scores : a perseveration score of 1 for the first repetition, 2 for the second, 4 for the third ; 8 for the fourth, etc.

On the first testing 30 of the final 84 subjects earned perseveration scores ; on the second testing 34 subjects. Only 15 subjects got this score on both occasions. The average perseveration score on the first testing was 1·52 ; on the second testing 1·33 ; S.Ds. 4·8 and 2·94 respectively. The reliability coefficient was only 0·11, which is not statistically significant. Those who received perseveration scores did no worse on the test than those who were not guilty of this " forgetfulness."

Fig. 2 shows for each of the 24 test items three variables : number of errors in

final selection ; number of blocks tried out but finally rejected in favour of another ; " perseveration " scores.

From Fig. 2 a number of points of interest can be observed. As would be expected, the perseveration score follows fairly closely the number of blocks tried and rejected. Also the number of errors made is in moderate agreement with the other two scores. A1 is an exception to this, for to ensure that the subject really understood the test it was necessary to keep him at this first problem until he solved it correctly. A10 presented great difficulty to these subjects, as shown by the number of trials made, but there were many more ultimate successes on it than on the following two items. The other wide divergence between number of errors and rejected try-outs appears at the end of Set " B," where a good many subjects remarked that these were really easy, and happily fitted a block matching the one above or beside the space, in spite of reiterated instructions that the correct piece need not *match*, but that they were to complete the pattern in the best possible way so as to make a good, balanced design.

(f) *Timing*.—The first performance of the test was not timed ; but on the repetition it was decided to time the test to the nearest half minute. The subjects were told that accuracy was all-important, and no special attention was drawn to the presence of the stopwatch, which was left at the side of the table and started as soon as the preliminary instructions had been given and understood.

The time taken by the 84 subjects ranged from 5 to 51 minutes, with an average of 9·9 minutes, S.D. 6·12.

Of the 84 subjects retested, 78 were tested for the third time about four months later. On that occasion the time ranged from 4 to 29 minutes, with an average of 10·2 minutes. The average for these same 78 patients on the first repetition was 9·8 minutes, so contrary to what might have been expected, they actually took slightly longer on the average to do the test the third time than the second.

Halstead mentions a slight tendency for times to increase with age, and says, " There is also a slight but insignificant tendency for a wider variation in test times to occur in the ' over 30s '."(9) The results given here cannot be compared directly with his, as he was using the full Matrix Test given as a group test ; but they do seem to bear out his findings.

The correlation between the length of time taken and total score on Set " A " and " B " was calculated and found to be $-0{\cdot}156 \pm 0{\cdot}108$. Thus, there is a slight, non-significant tendency for accuracy and speed to be related positively for these senile patients.

4. Summary and Conclusions.

A special comparative study was undertaken of 100 senile dementia patients regarding scores, reliabilities, errors and various factors determining success or failure on 24 perceptual problems. This analysis was carried out in an effort to discover whether, in addition to the frequently observed quantitative changes which take place in intelligence with increasing age, qualitative changes could also be observed. Comparisons were carried out on various points between the experimental population on the one hand and samples of normal adult, normal child, schizophrenic and manic-depressive populations on the other.

The performance of the senile dements was roughly on a level with that of 8-year-old children ; it was slightly worse than the performance of manic-depressives and schizophrenics, and was approximately equal to that of the lowest 3 or 4 per cent. of the normal adult population.

As regards order of difficulty of the problems considered, no appreciable differences were found between groups of 2,790 adults, 104 children of ages 8 ± 1, and the group of 100 senile dementia patients, the orders correlating on the average 0·95.

As regards the test-retest reliability of the group of problems, it was found to be below the reliability found for normal subjects.

As regards the most frequent errors made, it appeared that there were no outstanding differences between normals and senile dementia patients. The position of the blocks was shown to be of importance in determining the errors made ; this was true for normals and seniles alike. A marked tendency was observed for the subjects to match either the design above the blank space or the design to the left

of it. This tendency accounted for 81 per cent. of the errors made by the seniles. The same tendency was evident in the normal subjects, where it accounted for 76 per cent. of the errors.

The time taken over the test was considerably longer than with normal subjects averaging 9·9 minutes, and very large differences were found among the subjects. This bore out a slight tendency previously found by other investigators for times to increase with age, and for wider variation in test times to occur in the older groups.

The above results all seem to point to the conclusion that while there is a considerable deterioration quantitatively in the senile patients, they do not differ qualitatively from the children and normal adults with whom they were compared. With regard to the types of error made, the reasons for these errors, and the order of difficulty of the problems, senile dementia patients agree so closely with normals that we must come to the conclusion that qualitatively identical ability is being tested throughout. While the data are derived from only one test, and can, therefore, not be regarded as definitely settling the problem of the existence or non-existence of qualitative differences in senility, they do show that with regard to one mental function at least the existence of such differences is more than doubtful.

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