THE TRANSFER OF IMPROVEMENT IN MEMORY IN SCHOOL-CHILDREN¹. II.

By W. H. WINCH.

I. The problem stated.—II. First Series of Experiments, School "E.F."—III. Second Series of Experiments, School "E."—IV. Third Series of Experiments, School "I."—V. Summarized Conclusions.

I. THE PROBLEM STATED.

IN a previous piece of work dealing with this subject², I endeavoured to show that children whose rote memories had been improved by training in one medium—for example, in poetry—became thereby more proficient in rote memory for subject matter of a different kind—for example, for geography or history.

Rote memory, doubtless from its previous excessive use and estimation, has been educationally under a cloud for some years past, perhaps unduly so. But whether that be the case or not, it is commonly thought to be of more importance to carry away accurately the *substance* of what is heard or read than the actual words. It is not indeed uncommon to find the one capacity placed, as it were, in antithesis to the other. It is often supposed that proficiency in rote memory is not positively related to proficiency in substance memory, and that improvement in the former brings with it no improvement in the latter. It becomes a matter of concern to the educationist, since it is of importance to him whether the exercise of the rote memory in the acquisition of certain educational elements furthers or hinders the

¹ An outline account of the above experiment with the suggested conclusions was given in a paper read at a joint meeting of the Aristotelian and British Psychological Societies and of the *Mind* Association, in London, in July, 1910.

² *British Journal of Psychology*, Vol. II. p. 284.

growth of that kind of memory which we all desiderate, namely, an accurate substance memory.

The following experiments were undertaken with a view of helping towards a solution of some of these questions. An attempt was made to discover

1. Whether there is any transfer of improvement in rote memory for meaningless things to substance memory for stories (i) by an auditory method, (ii) by a visual method.

2. Whether there is any transfer of improvement in rote memory for things with meaning—for example, poetry—to substance memory for stories.

II. FIRST SERIES OF EXPERIMENTS. SCHOOL "E.F."

A first series of experiments was carried out in a municipal school situated in a good neighbourhood. The school was organized as a Junior Mixed, and the whole of the first class, both boys and girls, comprising the upper division of a well-advanced but old Standard III, whose average age was 10 years 1 month, was set to do the work.

On one day in three successive weeks preliminary tests were given in substance memory. Side by side with these were given some tests in rote memory for meaningless things. The latter were done in order to provide material for finding the correlation between the two sorts of memory. In the fourth week, the class was divided into two equal groups on the results of the tests in substance memory. One of the two groups was practised once weekly for three successive weeks in rote memory whilst the other group drew difficult geometrical designs. In the seventh week the two groups were placed together again and worked a further test in substance memory. The results of this final test may enable us to tell whether the group practised in rote memory does better work in substance memory than the group not thus practised.

i. *Chronology of the Series.*

The following is a brief chronology of the work :—

Jan. 15th, 1909. 11.13 a.m. to 11.32 a.m. The whole class worked a test in substance memory. After a short interval, during which the room was cleared and the children walked quietly to and from the playground, a test was worked of rote memory for meaningless things from 11.47 a.m. to 11.57 a.m.

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Jan. 22nd. 11.5 a.m. to 11.23 a.m. The whole class worked a second test in substance memory. After an interval occupied as on the previous occasion, a second test in rote memory was done from 11.42 a.m. to 11.52 a.m.

Jan. 29th. 11.20 a.m. to 11.38. The whole class worked a third test in substance memory, and after an interval, occupied as before, worked a third test in rote memory from 11.45 a.m. to 11.55 a.m.

The class was now divided into two groups equal in substance memory.

Feb. 5th. 11.15 a.m. to 11.35 a.m. One group, hereafter called the practised group, worked a practice exercise in rote memory for meaningless things, whilst the other group drew geometrical designs in another room.

Feb. 12th. 11.21 a.m. to 11.41 a.m. The practised group worked a second exercise in rote memory, whilst the non-practised group drew designs as before.

Feb. 19th. 11.20 a.m. to 11.40 a.m. The practised group worked a third exercise in rote memory, whilst, as before, the non-practised group drew geometrical designs.

In all respects other than in the exercises specifically mentioned above, the curriculum for the two groups remained the same during the period of the experiment, and on

Feb. 26th, 11.10 a.m., the whole class worked a final test in substance memory.

A reference to the calendar will show that all the tests and exercises were done on Friday. It is of advantage to the regularity of the results if they are obtained on the same day of the week and after the same school lessons.

ii. *Tests employed and Method of Marking.*

(a) Specimen substance memory test.

The following passage was read to the children three times slowly: "Nero is a large Newfoundland dog. He lives at a farm-house, and is more useful than many boys are. Indeed his master says that he really could not get on without his faithful helper: Nero's master and mistress are very proud of him, and often tell people what a useful and clever dog he is. One day there was a visitor, who could hardly believe the stories they told about this wise animal."

The first reading occupied $1\frac{1}{2}$ minutes, the second 1 minute, and

the third 1 minute. The children were told that they were not required to remember the actual words; they could write out afterwards all they could remember in their own words. Just before the papers were collected, they were told that if they found they had omitted anything, they could write at the bottom of their papers, "I forgot to say so and so." In 15 minutes from the time of commencing writing, all the children had finished writing all that they could remember.

The tests were marked on a system of mnemonic units which depends upon the mental stage reached by the class experimented with. I have explained the method in my research on "Fatigue in Evening Schools¹," so that a brief reference here will be all that is necessary. Speaking generally, we aim to estimate as units those pieces of the total story which go in and out of consciousness together. We make a preliminary analysis, and work tentatively on that. In the course of our marking we are fairly certain to come upon the work of some child who has divided something which to us seemed unitary, that is, he has remembered one piece of it and forgotten the other. We add one to our units and go back again through the papers we have already marked. After a few experiences of this kind, we usually find ourselves in possession of an analysis, which, so long as we do not use it for classes of very inferior mental ability, will serve our purpose quite well. Speaking broadly, it is true to say that subjects, predicates and objects (where there are any) are, at this mental level, remembered or forgotten as a whole, and receive one mark; adjectival or adverbial adjuncts receive one mark; and connecting words other than "and" receive one mark. It is not theoretically satisfactory to regard these various constituents of substance memory as quite equal; the adverbial relations and the connectives indicating relationships between clauses are usually more difficult to remember than adjectives and subject—predicate—object. If many thousands of these papers were done under very varying conditions of teaching and the errors tabulated for various ages, we could obtain a scale of marks more satisfactory theoretically. But, in practice, it is quite possible to get valuable results with the system of marking above outlined. And, of course, it must be remembered that the reproduction of meanings only is required, not the words, nor the order of the words actually read to the children. A mark is allowed for any expression which conveys the requisite idea; indeed, I go further, and allow a mark for

¹ *Journal of Educational Psychology*, 1910, p. 85.

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anything which *to the child's mind* is mentally equivalent to a unit in the test.

The following piece of analysis may be of service:

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Nero is a dog .
      . . .
large . Newfoundland
Nero lives at a farm
Nero is useful
      .
      more than .
                .
                boys are
                .
                many
Indeed
Nero's master says .
      . . .
      sometimes
      that he could not do without him
      .
      really . the helper
                .
                faithful
    
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In one case above, where one unit only is given for "Nero lives at a farm," it appears that the general direction to count adverbial adjuncts as separate from subjects and predicates has been disregarded. It was thought, however, that "lives" was so existential a predicate that the real predicate in that case was not "lives," which might, indeed, have been taken for granted, but "lives at a farm." No additional meaning appears to be conveyed by the word "house" attached to "farm," so that its presence or absence was disregarded in the marking. If a child wrote, "Nero was a farmer's dog," it was of course held to be equivalent to the first and third units of the analysis given above.

(b) Specimen test of rote memory for meaningless things.

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v j d m
g c w s
    
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The children first learnt how to write down the letters they could remember when tests like the above had been read aloud to them. Then *five* of these as tests were given on each morning when the preliminary substance memory tests were also given; and *ten*, as training exercises, on the three occasions in subsequent weeks to the practised group only.

Each test was called out twice in 30 seconds; after which, as much of it as could be remembered was written down, 1 minute and 30 seconds being allowed for this. No apparent or audible articulation

was permitted. The worked papers were marked on the following scale: three marks were allowed for each consonant correctly remembered and correctly placed, two marks if it were remembered but was one place out, and one mark if it were two places out. It would have been more satisfactory, theoretically, if eight marks had been allowed for each consonant correctly remembered and correctly placed, as it is possible for a consonant to be remembered seven places out, and the remembrance even in such a misplaced way is worth something; whereas, on the system of marking actually used, any consonant displaced more than two places received no mark at all, even though it really occurred in the test. In practice, however, it was extremely rare to find a case in which any injustice was done by the easier system of marking actually adopted. It was useful to request the children to insert a "nought" in any position when they knew they had forgotten the letter which stood in that place. I will give a marked paper as illustration:

v	j	m	d
3	3	2	2
g	o	t	c
3	0	0	1

in which a total of 14 marks is obtained out of a possible maximum of 24.

iii. *Results.*

The first step in the analysis of the result was the division of the class into two equal groups for substance memory. An indication of the division follows:

Group A	Total marks for 3 stories	Group B	Total marks for 3 stories
1. K. A.	67	1. R. F.	67
2. S. D.	58	2. G. A.	63
3. S. V.	57	3. H. M.	56
.....	...		...
23. C. M.	30	23. F. W.	29
	<hr/> 1067		<hr/> 1068

Then, in the list of children in Group B, the total mark for the three tests in rote memory, which were done *pari passu* with the substance memory tests, was inserted and the two series correlated. I was aware from previous work that rote memory was to some degree positively correlated with substance memory in school children, and

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this work was done as a means of ascertaining whether low positive correlation would be accompanied by a transfer of improvement from one of the correlated functions to the other and, if so, to what extent.

The correlation was not worked out for Group A, since this group was to form the half of the class unpractised in rote memory, and consequently no question of transfer could arise.

TABLE I.

Showing the correlation for Group B only in

(a) *Substance memory.*

(b) *Rote memory for meaningless things.*

Marks for substance memory	No. of children	Av. mark per child, substance memory	Av. mark per child, rote memory
Over 55	3	62.0	235.0
55 to 50	5	53.6	190.0
50 to 45	4	47.0	215.5
45 to 40	5	43.4	230.8
40 to 35	2	39.0	185.5
Below 35	4	32.8	172.5

An inspection of the above table shows that some positive correlation is probable, but that it is likely to be small in amount. Worked out from the 23 individual cases by the Pearson formula $r = \frac{\sum xy}{n\sigma_1\sigma_2}$, r is found to be +.262, which, with such a small number of cases—the probable error being more than .1—must be regarded as a decidedly low value.

iv. *Improvement within the practice medium itself—rote memory for meaningless things.*

All the children, it will be remembered, had worked three series of 5 tests each *pari passu* with the tests in substance memory; the first week's average mark per child per test was 11.9, the second week's mark was 14.3, the third week's mark was 13.8. Then Group A discontinued memory work, whilst Group B worked three series of 10 tests each in three consecutive weeks. The average mark per child per test for the first week was 15.1, for the second week was 15.0, and for the third week 15.8.

It is a long way from 11.9 to 15.8 marks out of a maximum of 24, but it must be remembered that *both* groups worked the first three sets of tests, the *additional* practice of the practised group was that done during the last three weeks only. How far has the improvement due

to this *additional* practice been transferred to the final exercise in substance memory?

Unfortunately, three children in the non-practised group were absent on the occasion of the final test. C. C. had left the school, M. S. was suffering from a protracted illness, and K. H. was staying in the country. This group was now reduced to 20. To balance this loss, L. M., P. B., and E. B. in the practised group, who in the preliminary tests were equal to C. C., M. S., and K. H. respectively, were omitted from the final table of results, which follows.

TABLE II.

Showing the practised and non-practised groups compared in

(a) *The preliminary tests in substance memory.*

(b) *The final test in substance memory.*

Marks for 3 prel. tests in substance memory	Non-practised group			Practised group		
	No. of children	Av. mark per child per test in 3 prel. tests	Av. mark per child per test in final test	No. of children	Av. mark per child per test in 3 prel. tests	Av. mark per child per test in final test
Over 55	3	20.2	21.3	3	20.7	22.0
50 to 55	4	17.9	20.0	4	17.9	22.7
45 to 50	4	15.7	17.2	3	15.8	18.0
40 to 45	4	14.5	16.5	5	14.5	17.8
35 to 40	—	—	—	1	13.0	17.0
30 to 35	5	11.1	13.8	4	10.9	14.2

It is obvious that steady improvement has occurred in all sections both of the practised and non-practised groups. Much of this is doubtless due to growth; some of it may be due to the influence of the other subjects of the school curriculum; but the point of interest lies in the comparison of the corresponding sections in Groups A and B, the non-practised and practised groups. It will be seen that, in every case, when the corresponding sections are compared in the work of the final test, the section belonging to the practised group is superior. There is a steadiness and constancy about the transferred improvement which the low correlation of +.262 might not have led us to expect. Let us make some further rough quantitative comparisons. The additional practice of Group B in rote memory caused an advance from 14.0 (the third week's average mark per exercise for the members of Group B) to 15.8 (the average mark per exercise in the sixth week). This is a rise of approximately 13 %. But some of this was doubtless due to growth and would have occurred *without* the additional practice of Group B over Group A.

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Comparing the results for substance memory in the non-practised group, we see that without intermediate memory practice and after three weeks interval each section shows improvement in the final over the preliminary tests. This we shall consider an improvement due to growth. Turning now to the results for the practised group, we again find an advance in the final test on the results of the preliminary tests. There is every reason to suppose that there has been also in this case an improvement due to growth, but there is a bigger advance, section by section, on the preliminary work than in the case of the non-practised group. It seems fair to attribute this excess to the intermediate work in rote memory for meaningless things done by this group only. Group A rises from an average of 15.4 in the preliminary tests, with a mean variation of 2.5, to an average of 17.0 in the final test, with a mean variation of 3.2. Group B—the practised group—rises from an average of 15.5 in the preliminary tests, with a mean variation of 2.5, to 18.7 in the final test, with a mean variation of 2.9. There has been an improvement of approximately 10 % in Group A which we have decided to consider as an improvement due to growth. Let us suppose that 10 % of the improvement shown in Group B is also due to growth. This is not a very unreasonable supposition, since the groups as a whole, and indeed section by section, were very much alike to start with. Adding 10 % to 15.5 we get 17.05. Actually we have an average mark of 18.7, an excess of 1.7 over the 17.05. Let us regard this, as indeed we must do, unless it is a chance result, as due to the intermediate practice in rote memory. Now 1.7 on 15.5 gives a percentage improvement of 11 %. The improvement in rote memory for the same group was, we may remember, 13 %—a figure which included improvement due to growth. Just how much of this 13 % is due to growth without practice there is no means of telling from the data of this experiment, it is probably more than 2 % at any rate. So that we are faced with a rather striking result, namely, that about as much or more improvement, reckoned in percentages, as has been made in the practice medium itself—rote memory for meaningless things—has been transferred to the substance memory.

There is an alternative—the higher average in the final test of Group B as compared with Group A may be a *chance* result.

But we need merely to estimate the chances against *all* the averages for Group B, section by section, varying in one and the same direction as compared with the averages of the corresponding sections of Group A, to see how unlikely this is.

III. SECOND SERIES OF EXPERIMENTS. SCHOOL "E."

The second series of experiments was carried out in a municipal girls' school situated in a very poor neighbourhood. The children were rather backward for their ages, though proficient in school work of a mechanical kind. All the children in Standard IV (of an average age of 10 years 8 months at the commencement of the exercise) did the work, which, in this case, consisted of a series of visual tests and exercises in rote memory for meaningless things and substance memory for stories. Four tests in substance memory were given—two in a week—and on the results of these tests the class was divided into two equal groups. Then, for a period of several weeks, one of the groups did exercises in rote memory, whilst the other group worked exercises in arithmetic. In all other respects the school curriculum of the two groups was exactly the same. At the end of the practice period the two groups worked four more tests in substance memory.

i. *Chronology of the Experiment.*

A brief chronology of the experiment follows:

On Oct. 20th, at 11.20 a.m., all the class worked a test in substance memory: then on Oct. 22nd, a second; on Oct. 27th, a third; and on Oct. 29th, a fourth. All the tests were taken at the same time of day. The practice exercises in rote memory were taken by one group only, and began on Nov. 10th. Further exercises were worked on Nov. 12th, 17th, 19th, 24th, and 26th. Then, finding that the exercises succeeded each other too rapidly for the satisfactory production of what is known as improvement by practice, the intervals between the exercises were changed, and the exercises were taken one in each week instead of two. Further exercises were given on Dec. 1st, 8th, 15th, and 22nd. The Christmas holidays then intervened. The exercises were resumed and continued on Jan. 12th, 19th, and 26th. In all, thirteen exercises in rote memory were given, always at the same time of day. At the conclusion of this practice period, four more tests were given in substance memory for stories to both groups, to the group practised in rote memory and to the group not thus practised. The substance memory tests were given at 11.20 a.m. on Feb. 2nd, 4th, 9th, and 11th.

ii. *Specimen tests and exercises.*

(a) Test in substance memory.

"Two boys lived in a cottage by a river. Their father made them a little boat with a white sail. He promised he would come home early one day and they would sail the boat on the river. Not far away there was a mill and the miller had a big dog which looked very fierce. Several days passed but the boys' father could not leave his work. So the eldest boy said, 'Let us go and sail the boat by ourselves.' They went to the river and placed the boat on the water. The wind caught the sail and blew the boat along. The boys ran by the side shouting with glee. Suddenly there was a loud splash and the miller's dog sprang into the water. He was going to swim across to the other side but the little boat was in his way. He snapped at it with his strong teeth and smashed the pretty toy so that it would no longer float. The boys sorrowfully gathered up the pieces and went home to tell their father."

The stories were given to the children in writing and they were required to study them visually without audible articulation. Six minutes were allowed, after which they wrote down immediately what they could remember. They were given to understand that the exact words were not required, that they were to think of the meaning, not the words. They were allowed to insert, after reading their written work before giving it up, anything which they were aware they had omitted. The system adopted in analysing and marking tests in substance memory has already been explained—identical procedure was adopted in this case.

(b) Exercise in rote memory for meaningless things.

Eight consonants arranged in two lines were exposed for 30 seconds and the children were required to learn them visually without audible articulation. They were directed to fix their attention on the consonants successively from left to right, on the four consonants in the upper line first, then on the four in the lower line, and to keep on doing this until they were told to write them out. One minute 30 seconds was allowed for writing them down. Nine of these exercises were given on each occasion. The worked papers were marked exactly like those of the auditory exercises in the preceding series of experiments.

iii. *Results.*

I will show first the general correlation between rote and substance memories for the practised group only. It will be remembered that both groups of children worked all the tests in substance memory, whilst only the practised group worked the exercises in rote memory. It is not quite satisfactory to calculate correlation from exercises that are not worked during precisely the same period. In this case the rote memory exercises were done in the period intervening between the four preliminary tests in substance memory and the four final tests; but since there are 8 substance memory tests and 13 exercises in rote memory the resulting correlation cannot fail to have some value. No preliminary exercises preceded the first of the thirteen, so that it was thought fairer for correlation purposes to omit the first one; the correlation is therefore worked on the results of twelve exercises in rote memory.

TABLE III.

Showing the general correlation between

(a) eight tests in substance memory,

(b) twelve sets of exercises in rote memory.

Marks for substance memory	No. of children	Av. mark per child in substance memory	Av. mark per child per exercise in rote memory
Over 340	1	342.0	199.3
320 to 340	3	327.3	148.5
300 to 320	2	313.5	161.8
280 to 300	6	287.3	156.7
260 to 280	5	266.4	146.5
Below 260	4	245.0	150.6

It is probable from inspection of the table that some positive correlation exists, but the sequence for the marks for rote memory is too broken to allow us to feel much confidence. Worked out from the individual cases by means of the Pearson formula, the coefficient is found to be +.208, which, with a probable error of more than .1, scarcely gives us a result from which we can argue with any confidence except that we should be entitled to say, if positive correlation exists, that it is very small. Two children, L. R. and E. C., omitted two of the four final tests in substance memory; they are excluded from the above table.

iv. *Improvement within the practice-medium itself.*

I will now show the improvement made by the practised group in rote memory for meaningless things. In the first set of exercises the average mark per child was 148.2; but, for the reason just given, I do

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not propose to include this set in calculating the improvement made. I shall measure this by taking the average of the 2nd, 3rd, 4th and 5th sets of exercises as indicating the initial position of the children, and the average of the 10th, 11th, 12th and 13th as indicating their final position. The average of the former series is 153·6, with a mean variation of 15·3, whilst the average of the second series is 164·2, with a mean variation of 19·5. If the percentages of improvement are calculated for each individual, it is found that, of the 23 cases, 16 show improvement, one remains as at first, and six show a loss. Of the 16 cases which improve, 1 improves 23 %; 1, 18 %; 1, 17 %; 3, 16 %; 1, 15 %; 1, 12 %; 1, 11 %; 1, 9 %; 1, 8 %; 3, 7 %; 1, 3 %; 1, 2 %. Of those which show a loss, 1 loses 8 %; 1, 7 %; 2, 6 %; and 2, 2 %.

It is not asserted that the whole of this improvement—about 7 %—is a practice improvement; some of it is doubtless due to growth, by which I mean a natural change which would have taken place in the direction of greater facility even if no exercises had been given between the earlier and the later series. But there are no means of determining within the data of this experiment how great this change would have been.

v. *Transfer of improvement from rote memory to substance memory.*

Let us see how far, if at all, the improvement in rote memory is transferred to substance memory. I shall measure the improvement in substance memory by considering the average of the four preliminary tests in substance memory as the initial position of the children, and the average of the four final tests in substance memory as their final position. Without doubt we have a factor here also due to growth or the influence of the other subjects of the school curriculum; but in this case we have a means of estimating it. For we have two equal groups, equal, that is, in the initial series. Both show improvement, and it seems fair to suppose that the *excess* of improvement in the practised over the unpractised group may be a measure of improvement due to the special practice in rote memory, an improvement from which natural growth and the influence (if any) of the other subjects of the school curriculum has been eliminated.

We must, I think, be prepared to admit that some transfer of improvement has taken place unless we are willing to suppose that five sections out of the six into which Group B is divided come out higher in the final tests than the corresponding sections in Group A as a matter of chance only.

Let us consider the groups as wholes with a view of getting an approximate measure of general improvement. Thus, Group A scores a total mark of 2932 in the preliminary tests and 3394 in the final tests, whilst Group B scores 2944 in the preliminary tests and 3574 in the final tests.

TABLE IV.

Showing the practised and non-practised groups compared in

(a) *Four preliminary tests in substance memory.*

(b) *Four final tests in substance memory.*

Marks for 4 prel. tests	Unpractised group A			Practised group B		
	No. of children	Av. mark in 4 prel. tests	Av. mark in 4 final tests	No. of children	Av. mark in 4 prel. tests	Av. mark in 4 final tests
Over 150	3	153·7	172·7	3	155·0	178·7
140 to 150	3	144·3	158·5	3	145·0	166·2
130 to 140	4	134·5	145·0	4	137·0	151·7
120 to 130	6	124·8	150·6	6	123·8	154·5
110 to 120	3	117·0	145·0	4	114·7	139·7
Below 110	4	100·0	120·5	3	98·3	149·0

In Group A there is a percentage improvement of 16%, an improvement made without the special practice in rote memory.

In Group B there is a percentage improvement of 21%. We seem entitled to regard the excess of 21% over 16% as likely to be due to the special practice.

It has, doubtless, already been noticed that the fifth section of Group B compares unfavourably with the corresponding section of Group A in the final test. Of the six children in the whole of Group B who show no improvement in rote memory, it is surely significant that three belong to this section. The four children included in this section are M. G. who improves 2%, E. C. who loses 7%, L. R. who loses 8%, and F. T. who loses 2%. It is therefore quite in accordance with the hypothesis of transfer that this group does its final tests in substance memory *worse* than the corresponding sections of Group A.

It might be of some value to give the average percentage of improvement of each of the sections indicated in Table IV, together with the excess of the percentage improvement of the sections of Group B over the percentage of improvement of the corresponding sections of Group A.

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TABLE V.

Showing percentages of improvement in substance memory of Groups A and B, and the percentage improvement of rote memory in Group B.

Marks for 4 prel. tests in substance memory	Group A		Group B			Percentage gain in substance memory of Group B over Group A
	No. of children	Percentage improve- ment in substance memory	No. of children	Percentage improve- ment in substance memory	Percentage improve- ment in rote memory	
Over 150	3	12	3	15	8	3
140 to 150	3	10	3	13	10	3
130 to 140	4	7	4	10	9	3
120 to 130	6	20	6	24	9	4
110 to 120	3	24	4	22	-4	-2
Below 110	4	20	3	52	9	32

I am at a loss to explain the quite unusual percentage of improvement in substance memory shown by the lowest section of Group B. It is scarcely due to the transfer of improvement in rote memory, since the percentage improvement in rote memory of this section appears quite normal. Considering the two groups as wholes, it would probably be fair to regard some 3 % of the excess improvement of Group B over Group A as due to transfer. The improvement in rote memory seems to be about 9 %, if we disregard the group which shows a loss instead of an improvement. If we knew how much of this was a growth-effect for children of this age and mental status, we could subtract the amount from the 9 % and obtain the ratio of the percentage of improvement due to transfer to the percentage of improvement through practice in the practice medium. Such ratios are sorely needed all over the educational field; but, for the present, I fear I must be content with indicating the fact of transfer and expressing it in a roughly quantified way.

IV. THIRD SERIES OF EXPERIMENTS. SCHOOL "I."

A third series of experiments was carried out in a municipal girls' school situated in a fairly good neighbourhood. The children were "old for their standard," a technical educational expression which would be commonly interpreted to mean "backward for their age," though the two phrases do not quite cover the same ground. The point of interest in relation to these experiments lies in the fact that the children were below "saturation point" for their age and ability in most, if not all, of their school subjects. In cases like this, considerable improvement is usually obtained, and transfer of improvement is much

more probable than in schools where the native capacity of the children has already been employed to its utmost limit. The children who worked the tests and exercises comprised the whole of Standard V, which, at the time the experiment commenced, had an average age of 12 years 0 months. The ages were distinctly high, for the class was not yet half-way through its current educational year.

The general plan of the experiment was similar to that of the preceding ones. The class was divided into two equal groups on the basis of some tests in substance memory, and one of the equal groups was practised for a period in learning poetry by rote whilst the other group worked exercises in arithmetic. Very great care was taken that both groups should regard their work as of equal importance, though it was not intended that the sums should be so set and marked as to give an adequate basis for calculation of correlation between arithmetical and mnemonic functions. The precaution was taken since we are not unfrequently told that improvement in some mental function is not due to the exercise of that or of some allied function, but that it is due to the training of attention or will. I was anxious to give approximately as much training of attention or will training to one group as to the other, so as to preclude the reference of any subsequent differences in the groups to such a factor.

i. *Chronology of the Experiment. Tests and Exercises.*

All the tests and exercises were taken at 11 o'clock in the morning. On Nov. 23rd, 25th, 30th, and Dec. 2nd, 1909, the whole class worked tests in substance memory for stories. On the results of these four tests the class was divided into two equal groups.

On Dec. 14th one of the two groups (Group B), hereafter called the practised group, learnt by rote William Blake's "Nurses' Song," from "When voices of children...morning appears in the skies" (62 words); on this and the following occasions the remaining group worked "rule" sums whilst the practised group were learning poetry. On Dec. 16th, Group B learnt Fr. Dempster Sherman's "Daisies," from "At evening when I go to bed...into the meadows of the town." On Dec. 21st, Group B learnt "The Golden Crested Wren," by T. Miller, from "The smallest bird that can be found...rumped, crumpled every feather" (79 words).

On Dec. 23rd, Group B learnt Longfellow's "Slave's Dream" from "Beside the ungathered rice he lay...among her children stand" (81 words).

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The Christmas holidays now intervened, but the practice exercises were resumed on Jan. 11th, when Group B learnt Eliza Cook's "Cuckoo" from "How glad I shall be...so white and so pink" (88 words). On Jan. 13th Group B learnt Mary Howitt's "Sea Gull" from "Oh! the white sea-gull...an anchored boat" (83 words); on Jan. 18th, the remainder of Miller's "Golden Crested Wren" (91 words); on Jan. 20th, J. Taylor's "Snow" from "O come to the window" (98 words); on Jan. 25th, "I love the sunshine" by Mary Howitt (110 words); and on Jan. 27th, Mary Howitt's "Woodmouse" (104 words). Then the two groups were put together again and worked four more tests in substance memory, on Feb. 1st, 3rd, 7th and 9th.

The increase in the length of the poems was forced upon us as the exercises proceeded, otherwise several of the children would have reached perfect scores and so would have vitiated our results.

Specimens of the stories used and the analysis according to which the written results were marked have already been given. Six minutes exposure was allowed for each substance memory test and rote memory exercise. The work was done visually without audible articulation. The rote memory work in poetry was marked according to a very simple plan, namely, one mark was given for every word correctly given and correctly placed.

ii. *Results.*

I will indicate first the correlation between the two functions, rote memory for poetry, and substance memory for stories. The correlation thus obtained will not be based upon tests which are theoretically

TABLE VI.

Showing the general correlation between substance memory and rote memory for group B.

Marks for 8 tests in substance memory	No. of children	Av. mark in substance memory	Av. mark in rote memory
380 and over	3	384.0	787.0
360 to 380	2	369.0	756.0
350 to 360	2	353.0	764.0
340 to 350	6	345.5	726.5
330 to 340	2	335.5	766.0
Below 330	2	302.0	723.0

satisfactory from that point of view, since they were not done *pari passu*. The eight substance memory tests were done in two sets, four before and four after the 10 rote memory exercises, but, having regard to the fact that the number of tests in each function was considerable,

the resulting correlation cannot fail to have some value. It is possible to show this correlation for the practised group only, since Group A did not work any exercises in rote memory.

An inspection of the table of averages gives some ground for supposing that positive correlation exists; and if the coefficient of correlation be worked out from the individual cases by means of the Pearson formula, r is found to be $+0.373$; but the probable error is decidedly over $.1$. We should be safe in concluding that if a positive correlation exists, it is a small one.

I next propose to set out the improvement made by the practised group in rote memory for poetry. The group will be classified on the basis of the marks obtained in the preliminary tests in substance memory.

TABLE VII.

Showing improvement in rote memory in Group B.

Marks for 4 prel. tests in substance memory	No. of children	Av. mark per child for 1st, 2nd, 3rd, 4th exercises in rote memory	Av. mark per child for 7th, 8th, 9th, 10th exercises in rote memory	Percentage of improvement to nearest unit
170 and over	2	292.5	357.5	19
160 to 170	4	278.2	333.0	19
150 to 160	5	273.4	329.4	19
140 to 150	3	282.3	331.7	18
Below 140	3	279.0	350.7	26

Not only do the averages of each section within the group show a considerable and steady improvement, but there is no individual case in which improvement is not shown. It is not contended that all this improvement is due to practice; the girls are getting older and would have become more proficient as a matter of natural growth; but there are no data available to indicate how much of the increased proficiency is due to the latter factor. I estimate the combined efforts of practice and growth roughly at 20%.

Let us now see how far, if at all, this increased proficiency transfers itself to the work of the final tests in substance memory.

Taking the unpractised and practised groups as wholes and working from the individual cases, we find that, whereas Group A obtains an average mark per test of 38.6 with a mean variation of 2.8 in the preliminary tests and an average mark per test of 46.6 with a mean variation of 3.1 in the final tests, Group B, the group practised in rote memory between the preliminary and final tests, obtains an average mark per test of 38.4 with a mean variation of 2.7 in the preliminary

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tests, and an average mark of 48·8 with a mean variation of 2·6 in the final tests. The smaller variation in the final exercises of the practised group may indicate that the practice exercises have brought the members of the group nearer together. Group A improves approximately 21 % on its preliminary record, whilst Group B improves

TABLE VIII.

Showing Groups A and B compared

(a) *In four preliminary tests of substance memory.*

(b) *In four final tests of substance memory.*

Marks for 4 prel. tests in substance memory	Unpractised group A			Practised group B		
	No. of children	Av. mark per child per test in 4 prel. tests	Av. mark per child per test in 4 final tests	No. of children	Av. mark per child per test in 4 prel. tests	Av. mark per child per test in 4 final tests
170 and over	2	44·3	50·3	2	44·2	52·2
160 to 170	4	41·1	48·8	4	41·1	50·7
150 to 160	5	38·5	47·5	5	38·4	48·5
140 to 150	4	35·8	43·2	3	36·3	48·7
Below 140	2	33·6	42·6	3	33·2	45·3

approximately 27 %. We must clearly attribute to natural growth or the influence of the other school work much the greater part of the improvement shown in both cases; but the excess improvement of Group B—about 6 %—may perhaps be attributed to the effect of the practice exercises in rote memory. But it is advisable to show, section by section, that the averages of the whole groups do not unfairly represent the case.

TABLE IX.

Showing percentages of improvement in substance memory of Groups A and B, and the percentage improvement in rote memory of Group B.

Marks for 4 prel. tests in substance memory	Group A		Group B		Percentage gain in substance memory of Group B over Group A
	No. of children	Percentage improve- ment in substance memory	No. of children	Percentage improve- ment in substance memory	
170 and over	2	13	2	18	5
160 to 170	4	18	4	23	5
150 to 160	5	23	5	26	3
140 to 150	4	21	3	34	13
Below 140	2	26	3	37	11

If we knew how much of the percentage improvement in rote memory was due to natural growth and the influence of work in other

school subjects, we should have a means of estimating how much of the excess percentage of improvement in the sections of Group B over the corresponding sections of Group A is due to transfer of improvement from the one function to the other, but what the former factors amount to I do not know. As before, I must be content with indicating the fact of transfer in a rough and inexact way. Assuming that the natural growth of the two groups is approximately the same, as it probably is in groups so much alike at the outset, we have, as I have previously pointed out, obtained an *excess* percentage of improvement in *substance* memory for Group B over Group A from which that factor is eliminated. But we are not entitled to say that an improvement by practice in *rote* memory of some 20% transfers to substance memory only a 6% improvement, for much of the 20% is a natural growth improvement and is not due to the special practice. The pedagogical question is: How much of the improvement *due to practice* in one function, if any, is transferred to another? The transfer seems clear, but the extent seems doubtful until we know how much of the improvement in the practice medium is itself an improvement through practice.

V. SUMMARIZED CONCLUSIONS.

1. It appears that improvement through practice in rote memory for things with and without meaning is followed by improvement in substance memory for stories. I have used the word 'transfer' of improvement, since transfer is the word commonly used in pedagogical discussions; but I am not unmindful of an explanation which would base the so-called transfer on the presence of elements common to the two functions. Pedagogically, the fact of 'transfer' should not lead us to adopt indirect or formal training methods unless the improvement transferred thereby is greater than that obtained by a direct attack on what is really required to be known.

2. If it is permissible to calculate correlations from such a small number of cases, it appears empirically that very low and indeed doubtful positive correlations between two mental functions, when one child is compared with another, may nevertheless be consistent with some real connection between those functions within the same mind; that is, improvement by practice in the one may produce an improvement in the other.