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## A Study in Spelling

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# A Study in Spelling

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IN the spring of 1911 I made an experimental study of one of the many problems involved in the teaching of spelling. The investigation was undertaken for the purpose of finding out whether the syllabized or unsyllabized form of the word was more favorable to the task of learning how to spell it. But the data yielded by the experiments have been used to throw light upon such additional problems as the significance of testing spelling ability directly after the learning period; changes in the tenacity or permanency of retention with age; changes in the efficiency of mechanical learning with age; the quantitative relationship of the errors due to the defective functioning of such mental processes as observation and immediate memory, temporary memory, and delayed memory; and sex differences in the efficient functioning of the mental processes just enumerated.

At the close of the investigation a number of deficits appeared. The children's ability to spell the words used in the experiments should have been determined before the controlled learning was undertaken, in order to obtain the proper base for calculating the improvement of the delayed recall. This would have made the results on delayed recall more convincing if not more reliable. A record of the errors of every child should have been kept throughout the whole series of experiments. This would have made it possible to allow more adequately for the disturbing effects of absences and to use all of the data of the study for the determination of sex differences. The word lists should have been shorter or more time should have been given to learn them, because this would have made the numerical expression of the amount of improvement larger and thus point more decidedly in one or another direction. With these shortcomings in mind I thought it would be desirable to repeat the investigation in improved form, but as the necessary coincidence of time and opportunity for the repetition have failed to appear, and as I have repeatedly been asked for the results, I have abandoned my former decision.

The subjects of the experiments were seventy-three school children of the fourth, fifth and seventh grades. At the beginning of the investigation their numerical distribution was 23 in the fourth grade, 26 in the fifth grade, and 24 in the seventh grade. During the course of the investigation the numbers in the fourth and seventh grades changed slightly on account of withdrawals from school. The children of every one of the three grades were divided by their teachers into two sections so as to make them approximately equal in spelling ability. Apart from the fourth grade this purpose was fairly well realized. As nearly as possible each sex was equally divided between the two sections of a grade.

The materials consisted of one hundred words per grade. Practically all of them were selected from the misspellings which appeared in the children's written school work. The selection was made in this way so that the investigation might be of direct practical value to the children. The children were of the opinion that the work was no more than a regular schoolroom exercise in spelling. Judging from the number of errors made in the first test the materials were not quite equally difficult for the different grades, but as the results of the first tests were taken as the bases from which to calculate subsequent improvement, this difference was of little or no consequence in making intergrade comparisons. On the first test the percentage of errors per child in the fourth grade was 19.73; in the fifth grade 24.21; and in the seventh grade 23.10. Because there were just one hundred words in the list of each

grade, the average percentage of errors is the same as the average number of errors.

Every word of the lists was written on a separate card of heavy white bristol-board with a rubber pen and thick black ink in such large letters as to enable the children to read it readily from their seats. In fact every word was written twice, once as a unit and again in syllables. For one section of each grade the unsyllabized words were used and for the other section the syllabized words. From the standpoint of spelling a much better than syllable division can be made of many words, because it is undoubtedly a disadvantage to break units which are already well known into smaller parts. If *tables* in *vegetables* is known by the learner nothing can be gained by syllabizing, at least so far as learning its spelling is concerned. The same is true of entire words which are familiar to the learner. According to some of the results obtained in this study it is also disadvantageous to syllabize a many syllabled word. For example "miscellaneous" was spelled very poorly by the section for which it was syllabized, very much poorer than by the other section. Such words, to avoid extreme complexity, should be divided into larger parts than syllables. The fact that all of the words, whether composed of many or few syllables, whether known or unknown, were syllabized was undoubtedly a disadvantage to the section which studied the syllabized words.

### WORD LISTS

Fourth Grade	Fifth Grade	Seventh Grade
monkey	grandfather	ignorant
needles	delighted	moisture
mending	pleasure	bamboo
neatly	courage	pumpkin
chestnuts	amazement	chocolate
roasting	journey	colony
many	villages	necessary
copper	understand	usually
voluntary	dividend	received
excusable	daffodil	different
carriage	improper	softens
chimney	commerce	region
dining	potatoes	statement
familiar	result	solution
guardian	woolen	Indians
eager	canals	significant
distinct	numbers	prosperous
mistake	exactly	occurrence
puzzling	units	America
promptly	manufacture	tobacco
enjoyment	mining	responsible
defeat	vegetables	requirement
correct	iron	satisfactory
accomplish	associate	implements
hindrance	people	cereals
column	subject	criminals
yellow	sentence	negroes
instead	traveled	population
engine	armies	intelligence
evening	attack	machinery

kettle	beautifully	warrior
handkerchief	decided	impetuous
organ	accept	councilor
director	presents	chieftain
companion	neighbor	disastrous
sermon	modifier	dormant
minister	adjective	terminal
behavior	lying	origin
congregation	enjoyed	glaciers
mellow	measure	mating
really	kingdom	resources
misspell	college	alternately
accurate	disappeared	suitable
pretty	wounded	granary
ceiling	selected	Spaniards
pronounce	valleys	commercial
earnest	believe	quotient
success	heroes	ferment
along	palace	chivalry
copied	kitchen	temperature
whistling	ladies	cucumbers
discovered	rescuer	cylinder
something	direction	diameter
presently	festival	latitude
joyful	patiently	allowance
again	treasurer	pirates
between	encamped	circumference
shoulder	established	jewelry
repeat	eleven	labeled
reciting	finished	Providence
accustom	victorious	trading
addition	justice	entirely
benefit	lances	determined
containing	agreed	starving
diminish	selected	estuary
coyote	window	palfrey
guitar	protects	statement
inquired	drawbridge	raisins
bruises	approach	Britain
volunteered	England	punctuation
appointed	anvil	increase
buried	faithful	irrigate
wriggle	instructions	attacked
difference	suddenly	governor
polite	soberly	colonists
nectarine	shadows	minstrel
heavier	gallant	withered
amusement	kinsman	equator
employed	traitor	disease
crimson	rebellion	character

climbing	accomplish	lodging
leafy	daughter	disobeyed
lengthen	glycerine	ruined
medicine	civilization	tyrannous
avenue	tempest	miscellaneous
nickel	heathen	insurance
excitement	pavilion	similar
regular	timbrels	jealousy
compelled	wrestling	spirit
mosquito	mercy	signifies
suggest	complete	personal
difficult	honor	subtrahend
costume	truthfully	valuation
picnic	journey	natured
prairie	adjoining	marry
easily	messengers	sociable
probably	reproachful	education
repetition	severely	challenge
secret	coming	triangle
shepherd	soldier	trapezoid

The whole investigation may be divided into four parts or periods. The first extended over ten days and was devoted to preliminary work; the second lasted twenty days and was spent in controlled learning and in testing the effects of the learning; the third period lasted ten days and like the second was spent in learning and testing; the fourth period lasted five days and was used to make a final test of the children's ability to spell the words of the lists. The preliminary work of ten days was thought to be necessary for the purpose of getting the children and the experimenter accustomed to the methods of the controlled learning, and to give the children of the syllabized sections some practice in learning to spell syllabized words. Fifty words per grade were used for this work, the last five of which appear as the first five in the above lists. The results of the preliminary work were discarded.

The twenty-day period was devoted to learning and testing. On the first day the first and second groups of five words each in the above lists, were presented to the children for learning and directly after the learning they were dictated for a written test. On the second day the first group of five words was dropped, the second group reviewed and the third group added. On the third day the second group was dropped, the third group reviewed and the fourth group added. This procedure was continued until the whole list of one hundred words had been covered. As every group of five words was reviewed the day after its introduction into the lesson and as every lesson was composed of ten words, a period of twenty days was required to cover the whole list of one hundred words.

The ten-day period also was spent in learning and testing. For the first lesson the first two groups of five words each were used; for the second lesson the next two groups; for the third lesson the next two groups. This procedure was continued until the whole list of words had been covered, ten days having been required for the purpose. Directly after the ten words of the lesson had been presented for learning they were dictated for a test. At the close of this period the whole list had been gone over three times both in learning and testing. For the purpose of understanding the nature of the results it is necessary to bear in mind that the first review of the list occurred the day after the first presentation and the first test, and that the second review occurred from 10 to 20 days after the first review, not counting off school days. The words were always presented in the same order.

On the last five days the words, at the rate of 20 per day, were dictated for a final test. These dictations were not preceded by any learning period. They occurred from 7 to 12 days after the last review. From this general description of procedure it is evident that the whole investigation extended over a period of 35 school-days, exclusive of the time devoted to preliminary work. During this time there were several withdrawals and a number of absences. Just how these are distributed over the various sections and grades is shown in the following table.

TABLE I  
Absences, Withdrawals, Etc.

	Grades	20-Day Period		10-Day Period		Final Test	
		Uns*	SS	Uns	SS	Uns	SS
Number of withdrawals.....	Fourth	00	00	00	00	00	00
Number belonging.....		11	12	11	12	11	12
Number of absentees.....		14	22	9	5	00	00
Percent of attendance.....		94	91	92	96	100	100
Number of withdrawals.....	Fifth	00	00	00	00	00	00
Number belonging.....		13	13	13	13	13	13
Number of absentees.....		19	5	7	15	00	00
Percent of attendance.....		93	98	95	89	100	100
Number of withdrawals.....	Seventh	00	00	1	0	00	1
Number belonging.....		12	12	11	12	11	11
Number of absentees.....		20	25	12	7	00	00
Percent of attendance.....		92	90	89	94	100	100

\* Uns—Section for which words were not syllabised.

SS—Section for which words were syllabized.

For the two first periods, during which the learning occurred, the percentage of attendance in the two sections of every grade is approximately equal, slightly lower for the SS of the fifth grade and a trifle higher for the SS's of the fourth and seventh grades. In the final test the SS's of the fourth and seventh grades also had the advantage of having their best attendance during the last review period. The reverse of this is true for the SS of the fifth grade. The final test was given to all of the children who had not left school. In the SS of the seventh grade one of the children withdrew before the final test, making the number of each section equal. Judging from his previous work, the spelling ability of this boy was exactly of average grade. For the purpose of making the number of children in each section equal the results of one child in the SS of the fourth grade were not used in calculating the results of the final test. The errors made by this child on the final test were equal to the average number of errors for the section. It is important to remember that absences did not interfere with calculating the average number of errors, for they were found by dividing the whole number of errors of a section by the average attendance and not by the number of children belonging.

We must next describe the method of presenting the individual words. The children with pencil and paper were placed at such distances from one another as to make copying impossible. The experimenter, facing the children, sat in front of a desk with the ten cards on which the words had been written in his left hand. The cards were held in such a way that the long edges rested on the surface of the desk and the sides with the words faced the children. A blank card was used to prevent the children from seeing the word on the last card or the one nearest them. The card nearest the experi-

menter was shown first. After the children had looked at the word the card was placed, face downward, on the desk beyond the remaining cards.

At the signal now all of the children looked for the word which the experimenter raised with his right hand and placed with the long edge on the upper edges of the remaining cards. Upon presenting the word the experimenter pronounced it twice in succession, once by syllables and again as a unit for the SS's and twice as a unit for the UnS's. The children of the fourth and fifth grades were given a period of seven seconds to look at the word, while the children of the seventh grade were given only five seconds for this purpose. After the period of seven seconds the word was turned down and the children wrote it, the SS's in syllables and the UnS's as a single unit. In the fourth and fifth grades thirteen seconds were allowed to write the word and in the seventh grade only ten seconds were allowed. The time periods for looking at and writing a word were made so short as to keep the children on the alert. The time for showing a word and that for turning it down were indicated by a tap from an assistant who used a stop-watch for the purpose of keeping tab on the time intervals.

After the ten words of the lesson had been gone over in the way described, the children's papers were collected and the words which they had just written were at once dictated for a test. This time all of the sections wrote the words as single units. At the close of the dictation the papers were collected. Then both sets of papers were examined for errors by the experimenter and the assistant. Every misspelled word was counted as only one error even though more than one letter in the word was missed. Probably the method of counting letter-errors is somewhat more reliable than that of counting word errors, but it has its disadvantages. It increases the task of tabulating the results and the liability to mistakes in counting the errors. In as many trials—from three to four thousand for each section—as were given in this investigation, the reliability would have been increased very little if any by counting letter-errors.

In classifying the data of the investigation, I have attempted to show the effect of syllabication upon the performance of the mental processes involved in learning to spell—upon the performance of these processes in isolation as much as possible. Thus, the errors which were made in the written responses following the presentation of the words, may be ascribed to faults of observation and immediate memory combined. The errors made after a dictation may be attributed to the shortcomings of temporary memory and the preceding faults of observation and immediate memory. The excess of errors made on a dictation over those made on the preceding presentation may be taken as a measure of the weakness of temporary memory alone. Moreover, the excess of errors on the final dictation over the errors of the first dictation, may be taken as a measure of the weakness of the delayed memory or permanency of retention, bearing in mind that two learning periods intervened. The final test was begun about 50 days after the beginning of the first dictation. The weakness of delayed memory might also be measured by subtracting the errors of the third dictation from those of the final test, but this would exclude the effect of the second and third learning periods upon the delayed memory. The best way to measure the effect of syllabication upon retention would be to subtract from the errors of an initial test those of the final test, but as such an initial test was not given this is impossible. The results, then, will show whether the syllabized or the unsyllabized word had the most favorable effect upon observation and immediate memory combined; observation, immediate and temporary memory combined; temporary memory alone; and delayed memory. The main purpose, however, of showing the number of errors due to the faults of these several mental functions is to find out what attention the functions should receive in the teaching of spelling.

Before presenting the results of the investigation, we must discuss one more point—the bases from which the improvement in the performance of



the various mental processes, from one learning period to another, was calculated. The number of errors made in the written responses to the first presentation were taken as the base for calculating the improvement made on the subsequent responses to presentation. More in detail, the base for calculating the improvement of a section in observation and immediate memory, is the percentage of errors per child made in the written response to the first presentation of the list. In a similar manner the errors made on the first dictation were taken as the base for calculating the improvement made on the subsequent responses to dictation. Restated, the base for calculating the improvement in observation, immediate and temporary memory combined, is the percentage of errors per child made on the first dictation of the list. The base for determining the improvement in temporary memory is the numerical difference of the two bases just described. The base for determining the improvement in delayed memory should be the number of errors made in response to an initial test before any attempt at learning was made, but as I failed to give such a test, I have compared the errors of the final test with those of the first dictation to determine which section made the best improvement in delayed recall or showed the best permanency of retention.

The following table shows the percentage of errors per child, made in the written response to the first, second and third presentations. It also shows the percentage of improvement of the second and third presentations over the first.

TABLE II  
Average Percentage of Errors of Observation and Immediate Memory

	Fourth Grade		Fifth Grade		Seventh Grade	
	UnS	SS	UnS	SS	UnS	SS
First presentation.....	14.95	9.45	14.11	13.18	12.45	13.40
Second presentation.....	8.43	5.69	9.63	8.86	8.27	6.98
Per cent improvement.....	6.52	3.76	4.48	4.32	4.18	6.42
Third presentation.....	11.09	5.57	10.08	10.35	7.04	7.35
Per cent improvement.....	3.86	3.88	4.03	2.83	5.41	6.05
Av. of 3rd and 5th lines....	5.19	3.82	4.26	3.59	4.80	6.24
Improvement per grade.....	4.25		3.93		5.52	

In the fourth and fifth grades the UnS's excelled, but in the seventh grade the reverse occurred. The average per cent of improvement of the UnS of the fourth grade exceeds that of the SS by 1.37, and in the fifth grade by .67; but in the seventh grade the improvement of the SS exceeds that of the UnS by 1.44 per cent. The sections with the syllabized words, therefore, gain upon those with the unsyllabized words with age until they overtake and finally surpass them. The probable explanation for this is that the task of holding in mind the letters and syllables of a word until it was written (especially if it had many syllables) was too great for the immediate memories of the younger children. Moreover, the task of observing and holding in mind a word which is already known as a unit is greater than it would be were the word not syllabized. While the spelling of none of the words was known by all of the children, nevertheless the spelling of many words was known by many of the children before the investigation was begun.

One of the interesting and practically important facts shown by Table II is the high percentage of errors made by the children in writing the words directly after having seen them. The child of average spelling ability in the UnS of the fourth grade fails in accurate observation and immediate retention on 14.95 words out of the whole list of 100. Indeed, it would be more

accurate to say out of half of the list, for surely half of the words of the list presented no spelling difficulties to the average child. Nobody who observed the conduct of our investigation would ascribe this high percentage of errors to a lack of effort on the part of the children. Practically all of the children enjoyed the work and tried hard. The work was carried on as a regular lesson in spelling. If these figures are at all reliable, it is very important in the teaching of spelling to make certain that the children can at least write the word correctly directly after having seen it. A comparison of Table II with Table IV shows that more errors are due to observation and immediate memory than to faults of temporary memory. Excepting three results, this is true of every grade and each section of every grade for every presentation. In some cases the errors due to faults of observation and immediate memory are almost three times as numerous as those due to faults of temporary memory.

Table III shows the percentage of errors per child made on all but the final dictation, and the per cent of improvement of the second and third dictations over the first.

TABLE III

## Average Percentage of Errors of Observation, Immediate and Temporary Memory

	Fourth Grade		Fifth Grade		Seventh Grade	
	UnS	SS	UnS	SS	UnS	SS
First dictation.....	21.65	17.80	23.40	25.02	21.55	24.65
Second dictation.....	14.17	10.83	16.02	19.22	14.18	15.44
Per cent improvement.....	7.48	6.97	7.38	5.80	6.37	9.21
Third dictation.....	15.25	9.57	17.64	16.87	12.94	15.04
Per cent improvement.....	6.40	8.05	5.76	8.15	8.61	9.61
Av. 3rd and 5th lines.....	6.94	7.51	6.57	6.98	7.49	9.41
Improvement per grade....	7.23		6.78		8.45	

In every grade the percentage of improvement of the section with the syllabized words exceeds that of the section with the unsyllabized words, the percentages being .57, .41 and 1.92 for the fourth, fifth and seventh grades respectively. These differences are rather small, but it must be remembered that they represent the percentage of improvement per child and that the time allowed for studying the words was very short. The gain was all made during two observations of the word, if writing the word after a presentation be not counted as a part of the learning. At one presentation, the fourth and fifth grades were allowed seven seconds for looking at the word and the seventh grade only five seconds. During the two learning periods in which the excess gain was made, only 14 seconds were devoted to the learning of a single word, and 1,400 seconds or 23 and 1/3 minutes to the learning of the one hundred words. The total amount of time spent in learning by the seventh grade during the two periods was only 16 and 2/3 minutes. The probability is that with another review, the SS's would have surpassed the UnS's by much larger amounts in at least the fourth and fifth grades. In these grades (see Table III) the UnS's improved much more than the SS's on the second dictation, but on the third dictation the reverse occurred. It is likely, therefore, that the SS's of these grades were just beginning to show the superior effects of syllabication when the experiments had to be concluded. In learning to spell a syllabized word the effect of the learning may be retained longer than when the word is unsyllabized, and this advantage may not appear until the word is relearned. It is also likely that teaching the children to

syllabize their words in spelling gives them a better method of learning to spell strange words, and this would be a permanent acquisition. When asked to spell a strange word of considerable length, all of us find it advantageous to syllabize the word.

The last series of figures in Table III shows the average improvement per grade. The fifth grade did not improve quite as much as the fourth, but the seventh grade surpassed both the fourth and the fifth grades, the fourth by 1.22 per cent and the fifth by 1.57 per cent. We may therefore conclude that the kind of mechanical learning involved in spelling can be done more effectively by the children of the upper grades than by those of the intermediate grades. In this connection it is well to remember that the learning time of seventh grade children was much shorter than that of the other children. In this respect our results are in line with those of other experimental work. As many of the children of the seventh grade are adolescent we may infer that adolescent children like this kind of mechanical work as well as the younger children and that they can do it better. The children of the seventh grade showed just as much interest in the work as did those of the fourth and fifth grades.

The figures of Table IV were obtained by subtracting those in Table II from the corresponding figures in Table III. The table shows the percentage of errors per child due to what was forgotten during the short interval between a presentation and the subsequent dictation. About six minutes elapsed between the presentation of a word and its subsequent dictation. It also shows the percentage of improvement of the second and third dictations over the first.

TABLE IV

## Average Percentage of Errors Due to Faults of Temporary Memory

	Fourth Grade		Fifth Grade		Seventh Grade	
	UnS	SS	UnS	SS	UnS	SS
First dictation.....	6.70	8.35	9.29	11.84	9.10	11.25
Second dictation.....	5.74	5.14	6.39	9.36	5.91	8.46
Per cent improvement....	.96	3.21	2.90	2.48	3.19	2.79
Third dictation.....	4.16	4.00	7.56	6.52	5.90	7.69
Per cent improvement....	2.54	4.55	1.73	5.32	3.20	3.56
Av. 3rd and 5th lines.....	1.80	3.83	2.32	3.90	3.20	3.18
Improvement per grade....	2.82		3.11		3.19	

In the fourth and fifth grades, the sections which studied the syllabized words again surpassed the other sections, but in the seventh grade the sections have the same average improvement. The figures on the improvement per grade indicate that temporary memory improves somewhat with age. In general, therefore, the deductions made from this table run parallel to those of the preceding table.

The errors due the weakness of delayed memory or recall are given below in Table V. The table also shows how much the errors of the delayed recall or final test exceed those of the first dictation. This excess is taken as a measure of the permanency of retention. While permanency of retention is here not measured in the usual way by relearning, it is probably just as accurate for the purpose of making comparisons between the sections and among the several grades. The figures represent the percentage of errors per child for the whole list of words. As there were just one hundred words in

the list, the percentage of errors is the same as the actual number of errors per child.

TABLE V  
Errors of Delayed Memory

	Fourth Grade		Fifth Grade		Seventh Grade	
	UnS	SS	UnS	SS	UnS	SS
First dictation.....	21.65	17.80	23.40	25.02	21.55	24.65
Final dictation.....	30.91	23.91	31.07	30.69	25.00	22.45
Difference in percentage...	-9.26	-6.11	-8.67	-5.67	-3.55	2.20
Loss per grade.....		-7.69		-7.17		-0.68

In the final test which was not preceded by any learning period and which began seventeen days after the beginning of the third dictation, the sections studying the syllabized words surpassed the other sections by 3.15 per cent in the fourth grade, 3 per cent in the fifth grade, and 5.75 per cent in the seventh grade. Teaching the children spelling by dividing the words into syllables apparently gives more permanent results than not dividing the words. Of course, we should not continue to divide the word after the purpose of the division has been attained.

The fact that all but one of the sections made a much larger percentage of errors on the final dictation than on the first, and the further fact that all of the sections made from two to three times as many errors on the final dictation as on the third which preceded the final by about fifteen days, shows very clearly how poorly the child's spelling ability is tested by the dictation which directly follows the learning period. Testing the child's spelling ability directly after the child has attempted to learn the words is, if not frequently supplemented by other tests, very bad practice for a number of reasons. As brought out above it is not a true test of the child's spelling ability, and is therefore likely to deceive both the teacher and the child with the consequence that neither makes the right effort. It also fails to impel the child to learn with the right intention. The child, to secure the best results, should learn his spelling lesson with the intention of remembering the spellings permanently, and this can be secured only by tests for which the child has received no immediate preparation. If the child knows that tests in spelling will be given without warning, this very knowledge will have the effect of greater permanency in the results of the learning or preparation. The child should not be trained to study his spelling lesson with the sole intention of making a good recitation directly after the learning.

The last line of figures in the table shows that the children of the seventh grade lost much less of what they had learned than the children of the other grades. Therefore the tenacity or permanency of retention increases with age. At what age the greatest tenacity has been attained is not definitely known. James was of the opinion that the tenacity of retention diminished with age, that it was best in infancy and poorest in old age. Meumann believed that it was better in school children of all ages than in adults. In his "Economy and Technique of Learning" Meumann reviews studies on the permanency of retention in which it was found that children reached the greatest permanency at the ages of eleven to twelve. But in these reviews nothing is said about the number of repetitions which the children made during the original learning. If a child of six must repeat a given material twenty times to learn it and a child of fourteen only ten times then it is very likely that the six year old will retain it the longer, for frequency of repetition makes for permanency.

If permanency of retention increases with age until the close of the elementary school period and if learning ability also increases up to and beyond this period (on the latter point there appears to be no disagreement) then, from

the standpoint of child psychology, children should not be permitted to leave school at the close of the elementary school period. At present children are kept in school by the compulsory attendance laws during the period of relatively poor learning ability, and are permitted to leave school about the time when increased learning ability and permanency of retention make it possible for them to profit substantially from schoolroom education.

For the sake of facilitating comparisons I have placed together in the following table, the average per cent of improvement in all of the mental functions for each section in every one of the three grades.

TABLE VI  
Average Percents of Improvement

	Grade	Uns	SS	Dif.
Observation and Immediate Memory . . . . .	Fourth	5.19	3.82	-1.37
Observation, Immediate and Temporary Memory . . . . .		6.94	7.51	.57
Temporary Memory . . . . .		1.80	3.83	2.03
Delayed Memory . . . . .		-9.26	-6.11	3.15
Observation and Immediate Memory . . . . .	Fifth	4.26	3.59	-.67
Observation, Immediate and Temporary Memory . . . . .		6.57	6.98	.41
Temporary Memory . . . . .		2.32	3.90	1.58
Delayed Memory . . . . .		-8.67	-5.67	3.00
Observation and Immediate Memory . . . . .	Sixth	4.80	6.24	1.44
Observation, Immediate and Temporary Memory . . . . .		7.49	9.41	1.92
Temporary Memory . . . . .		3.20	3.18	-.02
Delayed Memory . . . . .		-3.55	2.20	5.75

Excepting the results for observation and immediate memory combined in the fourth and fifth grades and those for temporary memory in the seventh grade, the results of all of the grades show that syllabizing words has a favorable effect upon the functioning of all of the mental processes involved in spelling and isolated in this investigation. But, as pointed out before, it is probable that words with many small syllables should be separated into larger than syllable-divisions to obtain the form most favorable to learning how to spell them. This appears to avoid needless complexity and a futile arrest of the synthetic activity involved in spelling. Small syllables by themselves usually present no spelling difficulties, and therefore they do not require individual attention. The synthetic or unifying activity in spelling is again needlessly arrested when words or parts of words are syllabized for children who can already spell them but who may have to repeat them for the sake of permanency or because they appear in connection with unknown elements.

As individual records of the children's errors were kept during the ten-day period and for the final test, these data were used for the purpose of making a comparison of the sexes. During the ten-day period there were seventy-two children, forty-two boys and thirty girls, and for the final test there were forty boys and thirty girls. Taking children as they are found in the grades, these numbers are rather small for the purpose of obtaining reliable results on sex differences in spelling ability. Nevertheless the general results are in agreement with other results somewhat similar in character.

The following table will show the number of boys and girls belonging to every one of the three grades and the percentage of their attendance. It will also show for each of the sexes the average percentage of errors in observation and immediate memory as made on the third presentation; the errors of observation, immediate memory and temporary memory combined as made on the third dictation; the errors of temporary memory as shown by the

difference between the two sets of errors just described; the errors of delayed memory as shown by the final test; and the errors of retention as indicated by the difference between the errors of the third dictation and the final test. The third column of figures in the table shows the excess percentage of errors for the boys.

TABLE VII  
Sex Differences

		Av. Percent of Errors		Excess of Errors	No. Children belonging		Av. Percent of Attendance	
		Boys	Girls		Boys Girls		Boys	Girls
Grade 4	1 Third Presentation...	8.63	7.50	1.13	14	9	94	93
	2 Third Dictation.....	12.37	12.14	.23	14	9	94	93
	3 Difference .....	3.74	4.64	-.90				
	4 Final Test.....	27.08	27.89	-.81	13	9	100	100
	5 Dif. between 2 and 4..	14.71	15.75	-1.04				
Grade 5	1 Third Presentation...	11.14	7.58	3.56	19	7	93	89
	2 Third Dictation.....	18.12	14.84	3.28	19	7	93	89
	3 Difference .....	6.98	7.26	-.28				
	4 Final Test.....	33.16	24.71	8.45	19	7	100	100
	5 Dif. between 2 and 4..	15.04	9.87	5.17				
Grade 7	1 Third Presentation...	8.00	6.67	1.33	9	14	94	90
	2 Third Dictation.....	15.77	12.94	2.83	9	14	94	90
	3 Difference .....	7.77	6.27	1.50				
	4 Final Test.....	23.50	23.86	-.36	8	14	100	100
	5 Dif. between 2 and 4..	7.73	10.92	-3.19				
All Grades	1 Third Presentation...	9.62	7.13	2.49	42	30	93	91
	2 Third Dictation.....	15.69	13.12	2.57	42	30	93	91
	3 Difference .....	6.07	5.99	.08				
	4 Final Test.....	29.25	25.27	3.98	40	30	100	100
	5 Dif. between 2 and 4..	13.56	12.15	1.41				

In compiling the above table the ages of the children should have been taken into consideration, but the numbers were too small for this purpose and a record of the ages was not kept. The results of the table would be more significant if the sex differences in the amount of improvement for the several mental functions were shown, but this was impossible because the individual records for the twenty-day period were not kept. If the amount of improvement could be shown the disturbing effect of previous training would have been eliminated. The disturbing effects of a lack of uniformity in previous training are, however, eliminated for temporary memory (see lines numbered 3 in Table VII) and for permanency of retention (see lines numbered 5 in Table VII). The figures therefore on temporary memory and permanency of retention are the most significant and I shall limit the discussion to these. In the fourth and fifth grades the boys excelled in temporary memory, but in the seventh grade the girls excelled to such an extent as to offset the boys' advantage in the other grades. In permanency of retention the boys excel in the fourth and seventh grades, but are excelled by the girls in the fifth grade to such an extent as to offset the advantage of the boys in the other grades by 1.41 per cent. In general the figures on sex differences support the contention that the girls have a memorial superiority over the boys. Whether this is due to a difference in endowment or physiological maturity it is impossible to say. At all events the difference is slight, but might have been somewhat greater had the girls' attendance been as good as that of the boys. The girls'

superiority in permanency of retention may act as a handicap to originality in which the male sex is supposed to excel.

In conclusion I wish to enumerate the statements which are supported by the results of this investigation. Taken in connection with the results of related investigations, perhaps most of them may be regarded as sufficiently reliable to be of service in making predictions. The girls surpass the boys in permanency of retention as shown by the fact that they lose less in the interval between the temporary and the delayed recall. In general the syllabized form of the word promotes the learning process in spelling. Permanency of retention, when measured by the amount of loss between temporary and delayed recall, improves with age, until the close of the elementary school period at least. A very large percentage of the errors made in spelling is due to faults of observation and immediate memory. The results of the spelling test which is given directly after a learning period are a very inadequate measure of spelling ability. The efficiency of observation and immediate memory combined and that of temporary memory, as these are involved in spelling, increase with age until the close of the elementary school period at least.

