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In a series of three experiments involving 104 individuals, the effect of chunking sentences (the spatial separation of sentences into small groups of meaningfully related words) upon the reading rate and comprehension of mature readers was investigated. Passages and questions from a standardized reading test were displayed via an electro-mechanical device which allowed reading times to be recorded. Five experimental chunked formats were compared with each other and one selected for further study. There was no important or statistically significant difference between the experimental chunked format and the control format either on the reading rate or on comprehension measures. However, another control format (no punctuation or capitalization) did result in significant decrements in reading rate and comprehension. It was concluded that the spatial separation of reading material into meaningfully related groups of words does not improve the reading efficiency of mature readers. Tables, references, and examples of the various formats used in the experiments are included. (Author/CM)

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December 1968

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HEALTH, EDUCATION, AND WELFARE
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ABSTRACT

Recent research results have indicated that the spatial separation of sentences into small groups of meaningfully related words facilitates free recall, rote memorization, and comprehension. In a series of three experiments, involving 104 individuals, the effect of chunking sentences upon the reading rate and comprehension of mature readers, reading at their normal rates, was investigated. Passages and questions from a standardized reading test were displayed via an electro-mechanical device which allowed actual reading times to be recorded. Five experimental chunked formats were compared with each other and one selected for further study. The chunking of the material was arbitrarily intuitive but a subsequent analysis indicated that the chunked boundaries usually coincided with the major phrase boundaries of immediate constituents. There was no important or statistically significant difference between the experimental chunked format and the control format either on the reading rate or comprehension measures. However, another control format, no punctuation or capitalization, did result in significant decrements in reading rate and comprehension. It was concluded that the spatial separation of reading material into meaningfully related groups of words does not improve the reading efficiency of mature readers.

SUMMARY

Recent research results have indicated that (a) the chunking of sentences into small groups of meaningfully related words facilitates the free recall of the sentences, (b) when passages are presented in segments to conform to the phrase structure of the sentences, rote memorization is more rapid, and (c) when paragraphs are broken up at the major boundaries by immediate constituent analysis, comprehension is higher for mature readers who are reading at a rate faster than normal. If the spatial separation of sentences into small groups of words facilitates performance in the above areas, it would follow that the next area to be investigated is the effect of chunked reading passages upon the reading speed and comprehension of mature readers who are reading at their normal rates.

The passages and questions from a standardized reading test were used as reading materials and comprehension measures. They were displayed via an MTA Scholar, a device which allows self-pacing. The reading times for the passages were recorded by using an event recorder with the MTA Scholar.

In the first experiment, Study I, the reading passages were retyped in five experimental formats and one control format. Each S received each of the passages in a different format according to a Latin square design. A total of 18 Ss were tested in three groups, six Ss per Latin square group. No single experimental format appeared to elicit rate or comprehension scores higher than the others. However, Ss ranked their preferences and one format was consistently preferred. That format was a medium length chunk (from 1 to 5 words in length) in a vertical array, i.e., one chunk per line.

Although the passages were chunked by separating words into meaningfully related groups in an intuitive manner, the resulting boundaries between chunks usually coincided with major phrase boundaries as determined by a subsequent immediate constituent analysis. That is, a consultant to the experiment performed an immediate constituent analysis, bracketing the syntactically significant substrings of each sentence, and there was an average of 2.7 parentheses within chunks and an average of 6.2 parentheses between chunks in one passage.

In Study II, three passages in the conventional format and three passages in the medium length chunk format were given to two groups of eight Ss per group. The six passages were presented in a design

which balanced the order of administration and the passage contents. The results indicated that reading rate and comprehension scores for the two formats were approximately equal.

In Study III, the main experiment, 70 male and female college students volunteered as paid participants. Within-subject variations on reading rate and comprehension due to initial fluctuations in reading strategies were reduced by administering two tests. All Ss received the first test in a traditional format and the second test in one of three different types of formats. For the second test, Group I (N = 30) received the experimental chunked format; Group II (N = 30) received a newspaper type of format (even right and left hand margins justified by using the IBM "Executive" typewriter) as a control; and Group III (N = 10) received another control type of format which had no capitalization or punctuation. Unreliability of scores due to small samples of reading rate and comprehension, plus possible initial negative transfer effects, were reduced by requiring each S to take an entire test in a single format. The time limit for the test was restricted to the reading of passages (6 minutes), thus eliminating the variance contributed by the time required to answer questions. To further stabilize reading strategies during the first test, Ss were given immediate feedback regarding the correctness of each answer by a special testing device. In order to help provide constant motivation, Ss were paid on the basis of correct answers. In order to provide a meaningful control for the experimental format, the newspaper format was developed which had exactly as many vertical lines as the experimental format. For the newspaper format, the average number of parentheses on one passage between words within lines was 3.7 and between lines was 2.8. The second control format, no punctuation or capitalization, was used to further provide an indication of the importance of any accrued benefit of the experimental format. If no advantage was found for the experimental format, this control format would provide an indication of the precision and appropriateness of the experimental procedures. In all tests for all Ss, the task was to correctly answer as many questions as possible on the reading passages.

There was no important or statistically significant difference between the experimental chunked format and the newspaper type of format either on the reading rate or comprehension measure. However, the no punctuation and capitalization format did result in decrements in reading rate and comprehension which were statistically significant as compared to the newspaper type of format. Further analyses compared passages which all 60 Ss completed and also reading times for individuals who had exactly the same number of correct answers. These analyses failed to show any difference in favor of the experi-

mental chunked format. Additional analyses designed to detect a possible interaction between the type of reader and the effect of the format, failed to show an advantage for chunking in any of the following groups of readers: rapid, slow, accurate, and inaccurate.

Although in general it is dangerous to draw conclusions based upon "no difference" results, it appears that the failure to find a significant difference was not due to a lack of experimental precision. It seems reasonable to conclude that for mature readers the spatial separation of reading material into small groups of meaningfully related words will not appreciably affect either reading rate or comprehension. This implies that there would be no practical advantage to chunking materials read by mature readers such as textbooks. It also suggests that reading behavior is such a highly developed skill that further improvements in format are not likely to yield important improvements in reading performance.

INTRODUCTION

In 1956, Miller advanced evidence that short-term memory was limited more by the number of items than by their informational value, and Miller used the term "chunk" to refer to coding of items of information into meaningful units. Cohen (1963) found that: "categorized word lists are handled in immediate memory as so many chunks of information rather than as so many individual words [p. 234]." Recent evidence (e.g., Murdock, 1968) still supports Miller's coding principle and the topic of grouping or chunking in memory is presently receiving much attention (see Bower, 1968).

Recent research using the linguistic technique -- immediate constituent analysis -- has suggested that phrases or constituent segments are also the perceptual units of the spoken language (Fodor & Bever, 1965). In reading, it has been reported (Mehler, Bever, & Carey, 1967) that more eye movement fixations occur on the first half of phrase structure constituents. Thus, the grouping or chunking principle appears to have been extended from immediate memory to reading and listening.

Further evidence of the relevance of the chunking principle to meaningful verbal material comes from Epstein (1967) who found that the chunking of sentences facilitated the free recall of the sentences, and also Anglin & Miller (1968) who found that the rote memorization of continuous prose passages was more rapid when the passages were presented in segments that conformed to the phrase structure of the sentences. If meaningful verbal material tends to be coded into chunks or phrases by the reader, then the pre-organization of reading material into meaningful word groupings might improve the efficiency of reading as it has improved the free recall of sentences and the memorization of prose passages.

Graf and Torrey (1966) have reported that the comprehension of paragraphs is higher for material which is broken up at the major boundaries by immediate constituent analysis. However, it would be dangerous to generalize the results of this study to mature readers who are reading textbooks, novels, newspapers, etc. Two reasons can be given for this lack of generalizability: (a) the experimental reading material was not compared to ordinary reading material, but was compared to reading material which was purposely broken up at minor boundaries by immediate constituent analysis, and (b) the readers were not reading at their normal reading rate, but at a faster rate which was controlled by the experimenter.

If it could be shown that the chunking of reading material would facilitate reading efficiency, then it would probably be a practical advantage to pre-organize materials which are read by many people, such as textbooks. Earlier applied researchers have studied this possibility with conflicting results. North and Jenkins in 1951 report a meaningfully segmented type of format produced higher comprehension scores and faster reading speeds. They suggest that their separation of words into "thought" units supplemented the punctuation and grammatical cues and facilitated reading. Two later studies failed to confirm this result. However, a close examination of these two later studies renders their results questionable. Klare, Nichols, and Shuford (1957) allowed a fixed amount of time, 25 minutes, to read a single passage, 1260 words in length. Thus, the average reading rate for all subjects was 50 words per minute, a rate far too slow to generalize to a normal reading situation. Coleman and Kim (1961) found a substantive difference (1.2 questions on a 20 question test) in favor of the experimental materials but the difference was not statistically significant. More recently, Coleman and Hahn (1966) failed to find that a vertical format improved readibility but the vertical format consisted of only one word per line.

In summary, it appears that recent research on memory using chunks and phrases suggests that the segmentation of meaningful prose material may improve reading efficiency while relevant applied research, outlined in the preceding paragraph, is conflicting. Thus, the purpose of the following study was to answer as definitively as possible the questions: For mature readers, is there an advantage to chunking reading material? If there is an advantage, what type of an advantage is it; that is, does it improve comprehension per unit of material without influencing reading rate or does the advantage involve a complex interaction between reading rate and comprehension? Is there an interaction between the type of reader -- fast or slow, accurate or inaccurate -- and the efficacy of chunking?

STUDY I

The purpose of this study was to compare five different experimental formats with a conventional format to ascertain which of the five should be compared with the conventional format in the main study.

Subjects. Eighteen male and female college students were paid a flat fee for particpating in the experiment.

Equipment. An MTA Scholar was employed as a device which allowed each S to control the presentation time for the reading materials and questions, and together with an event recorder, allowed E to record the actual amount of time each S spent reading passages and questions. A clock was provided for S which continuously recorded the time remaining on the test. (See Appendix A)

Materials. The passages and questions were taken from the Nelson-Denny Reading Test,[1] Form B. Each passage was retyped in six different formats. All materials in the entire project were typed using the IBM "Executive" typewriter, a variable spacing machine which produces a spacing of letters similar to that of a printed newspaper. Format A was the conventional type of format, single spaced with approximately 12 words per line. Formats B - F all involved the chunked style.

There are no firm rules for chunking reading material and the rules used for research materials are seldom given in the research reports. An immediate constituent analysis could be employed to chunk material, but even this technique involves somewhat arbitrary decisions when parentheses are being assigned to complex sentences. Even if the assignment of parentheses can be agreed upon, there is no rule which arbitrates decisions concerning the difference between major and minor boundaries. The chunking of materials by immediate constituent analysis would never be a practical procedure due to the time required to separate the material by this procedure and due to the fact that the procedures are so difficult to learn.

The only known published guidelines for separating sentences into groups of meaningfully related words were presented by Klare,

[1]by Nelson, M. J., and Denny, E. C. (Revised by Brown, J.I.) Houghton Mifflin Company, Boston.

et al. (1957). In general, these guidelines suggest that in forming the groupings, i.e., chunks, (a) modifiers should be placed with the words they modify, (b) clauses and phrases should be separated from the rest of the sentence, (c) chunks should never be broken due to lack of space at right hand margin, and (d) existing punctuation should be used to determine boundaries between chunks. When forming chunks according to this procedure, the length of a chunk becomes somewhat arbitrary. Thus, Study 1 investigated three different chunk lengths using the general guidelines above for designating chunks. First the material was broken up into chunks from three to ten words in length (Long Chunks). Then, the material in long chunks was broken up again so that there was no chunk longer than five words or shorter than two words (Medium Chunks). Finally, material in medium sized chunks was broken up again so that there was no chunk shorter than one word or longer than three words. Table 1 presents the number of sentences, long chunks, medium chunks, and short chunks for each of the eight Nelson-Denny Form B passages. Notice that the total number of sub-units in each category increases in an almost perfect linear fashion from sentences to short chunks. In order to provide a better indication of actual number of words per chunk for the various sized chunks, Table 2 presents, for each of the three chunk lengths, the percent of the total number of chunks that are of each number of words long. Notice that 95% of the short chunks are either two or three words long. Of the medium sized chunks only 12% were 2 words long. The long chunks are almost evenly distributed from four to nine words, with a small percent either three or ten words long.

Table 1

Number of Sentences, Long, Medium, and Short Chunks in each Passage of the Nelson-Denny, Form B

		UNIT		
Passage	Sentence	Long Chunk	Medium Chunk	Short Chunk
I	28	92	167	269
II	9	31	53	83
III	9	31	54	85
IV	7	28	59	84
V	14	31	60	89
VI	11	32	56	91
VII	14	30	57	91
VIII	7	29	56	86
Total	99	304	562	878

Table 2

Composition of the Short, Medium, and Long Chunks in terms of the Number of Words per Chunk Expressed in Percents

Words	Short	Medium	Long
1	5		
2	58	12	
3	37	35	2
4		33	11
5		20	15
6			19
7			18
8			16
9			13
10			6
Total	100%	100%	100%

The chunked material can be presented in various lengths and also in different types of formats. Although an infinite number of formats could be tried, the past research cited earlier appears to indicate that some type of vertical or horizontal format is most likely to elicit more efficient reading. The horizontal format is similar to the conventional format except that extra spacing is placed between chunks. In this study, four spaces were placed between each chunk. In the vertical format, each chunk was placed on a separate line and the chunks which do not introduce a sentence are indented in order to further cue the beginning of sentences. The short and medium sized chunks can be presented in both a vertical and horizontal format. However, the long chunks cannot be presented in the horizontal format since there is only space for one chunk per line. Thus, the five chunked formats were: Long Vertical (B), Medium Horizontal (C), Medium Vertical (D), Short Horizontal (E), Short Vertical (F). Appendix B contains samples of the six formats.

Design. The Ss were tested in a Latin square design such that each set of 6 Ss received each of the six passages in a different format. For each set of 6 Ss, the content of the first passage and all succeeding passages was always the same. However, the format of the first passage and each succeeding passage was different for each set of 6 Ss, according to the Latin square.

Instructions. The Ss were informed that they would take reading tests and that they should read as many passages and answer as many questions as they could during the 15 min. that they were allowed. The Nelson-Denny test has eight reading passages. Passage I is approximately 600 words in length and has eight multiple choice questions. Passages II-VIII have approximately 200 words each, and each has four multiple choice questions. For this study, Passage VIII was employed as an example passage and Passage I, the longest passage, was presented last. Ss were given the above information about the length of passages and number of questions on each passage.

Variables. Reading times in seconds for each passage were recorded by the event recorder. The number of questions answered correctly was available from a separate answer sheet. After the test was over, each subject was presented the practice passage typed in the six different formats and was asked to rank the six with respect to which format he would choose if he were required to take the test again in a single format.

Results. Table 3 presents, for each of the six formats, the mean reading times, correct answers, and preference ranking. The

regular format was read the fastest and its comprehension score (3.2) was comparable to other mean answers correct. Of the five experimental formats, no single format was definitely superior in that the highest comprehension scores tended to go with the slowest reading rates and the fastest reading times tended to go with the lowest comprehension scores. However, one format was clearly superior to the others in terms of ranked preference. Format

Table 3

Mean Reading Time, Correct Answers, and

Preference Ranking for each of the Six Formats

(N - 18)

Format	Reading Time (Sec.)	Correct Answers	Preference Ranking
A	49	3.2	4.2
B	55	3.3	3.3
C	52	2.9	3.3
D	57	3.3	2.3
E	54	3.2	4.2
F	54	3.1	3.7

D, the medium vertical format, had a mean ranking (2.3) one rank higher than the nearest format (3.3) and almost two ranks higher than the regular format (4.2). The preference for Format D was consistent in that it was preferred in each of the three Latin square sets.

Discussion. The above experiment failed to suggest that any of the experimental formats would improve the efficiency of reading. However, the exposure time for any single format was very brief, less than one minute. Any advantage to chunking may have been offset by an initial distraction of attention elicited by the newness of the formats. Although no single chunked format showed signs of being a more efficient way of presenting reading material, Format D was clearly preferred by the three groups.

STUDY II

The purpose of this study was to compare a regular reading format, Format A, with the preferred chunked format, Format D, to ascertain which format elicited the most efficient reading.

Procedure. Sixteen male and female college students were paid a flat fee for participating in the experiment. The MTA Scholar, the event recorder, and the clock were again used to present the same test as in Study 1. However, only Formats A and D were used in this study. The Ss were tested in two groups. Group 1 (N = 8) was presented the practice passage and the seven test passages in the following format order, D, ADADADA and Group 2 (N = 8) received an order, A, DADADAA, which balanced the first six experimental passages for the two groups. Passage I, the long passage which was placed last in this study, was not analyzed since all subjects did not finish this passage and it was in Format A for both groups. The instructions to the Ss were exactly the same as Study 1. The variables were reading times and correct answers for each of the first six test passages.

Results and Discussion. By adding the Group 1 Passage 1 data to the Group 2, Passage 2 data, and the Group 1, Passage 2 data to the Group 2 Passage 1 data, the comparison of Format A with Format D was balanced with respect to passage differences and individual differences for each set of two passages. Table 4 presents the mean reading times and correct answers for the two formats. Notice that Format D was read faster in two of the three comparisons. However, in these two instances, the comprehension scores were lower than Format A. Thus, these data do not suggest that Format D can be read more efficiently than A, the regular format.

Table 4

Mean Reading Time and Correct Answers

for the Conventional and Experimental Formats

	Reading Time (Sec.)		Correct Answers (No.)	
	Conventional	Experimental	Conventional	Experimental
	Format A	Format D	Format A	Format D
Passages 1 & 2	59	62	2.9	3.1
Passages 3 & 4	62	56	3.3	3.1
Passages 5 & 6	59	56	3.4	3.2

STUDY III

If the chunking of reading material elicits more efficient reading, then more elaborate experimental controls and testing procedures would be necessary to demonstrate its efficacy than were employed in Studies I and II. The experience, knowledge, and insights gained during Studies I and II provided the following design and procedural criteria for the third and final study.

1. In order to provide sufficient reading time to overcome any initial negative effects and to provide a sufficiently large sample of reading, an entire test needs to be presented in the chunked format.

2. In order to control large within-individual variations in reading speed which occurred in Studies I and II, each subject should be administered one entire test for practice.

3. In order to more precisely measure reading speed and compare it to comprehension measures, the time required to answer questions should not be a third contaminating variable as it was in Studies I and II.

4. In order to further reduce the variance of reading times, Ss should receive immediate feedback concerning the correctness of their answers to the questions on each passage so that within- and between-individual variations in strategies are allowed sufficient time to stabilize during the practice test.

5. In order to control for within- and between-individual variations in motivation, Ss should be paid in a manner that would provide an incentive to get each question correct.

6. Since a vertical format was shown to be the format most likely to elicit more efficient reading, it should be compared to a control which is similar in all respects except chunking.

7. In order to be better able to judge the precision of the experiment and the absolute size of any advantage which may accrue to chunking, another control type of format should be used which would undoubtedly produce a decrement in reading efficiency.

8. Finally, a sufficient number of subjects should be run so that the statistical analysis will detect as significant, a minimum, 10%, increase in reading speed.

Subjects. For their voluntary participation, seventy male and female college students were paid a flat fee plus a bonus for each correct answer. From the means and standard deviations in Studies I and II, it was estimated that 60 Ss would be required for statistical significance if chunking was an improvement over a conventional (control) type of format. Ten subjects were estimated as being required to show a statistically significant decrement for the second control format, i.e. one which had no punctuation or capitalization.

Equipment. The MTA Scholar and the event recorder were again used, as in Studies I and II, to present the experimental materials. The Scholar was programed in this study so that the clock ran during the reading of a passage and did not run while S was answering the questions on a passage. A Rapid Rater was used to provide immediate feedback concerning the correctness of each question answered. The Rapid Rater is a hand held device containing holes corresponding to alternative answers. When S chooses an answer by perforating an answer sheet, i.e. inserting a stylus into a hole, the choice is indicated as being correct or incorrect by the degree of puncture of the stylus.

Materials. Passages and questions from both Form A and Form B of the Nelson-Denny were used in this study. Passage VIII and its questions were employed as practice material during the instruction presentation for both forms of the test. In this study, contrary to Studies I and II, the order of presentation of the passages was exactly the same as the standardized test, i.e., Passage I, the long passage was first, Passage II was second. . . Passage VII was last. Form A of the Nelson-Denny was retyped in only one format, the conventional format, A, as was used in Studies I and II. Form B was retyped in three different formats. The chunked format (CHUNKED) was exactly the same as Format D in Studies I and II. A columnar newspaper type of format (NEWSPAPER) was constructed to be comparable to the chunked format. That is, a width of column was used which (by trial and error) would make the number of lines per passage equal to the number of lines in the chunked passage. This width was approximately two inches for all passages. Like a newspaper column, the right hand margin was justified using the variable spacing capability of the IBM "Executive" typewriter.

The columnar format above was used to construct the last type of format, a format which had no punctuation or capitalization (NO CAPITALIZATION). The letters and words on each line were in exactly the same positions as the newspaper format, except the commas, periods, question marks, etc., were omitted so that there was no punctuation remaining and the capitalized letters were replaced with lower case letters. Appendix C contains examples of the four formats.

In order to provide a better indication of the nature of the chunked material it was further analyzed into immediate constituents. Although the passages were originally chunked by separating words into meaningfully related groups in an intuitive manner, the resulting boundaries between chunks usually coincided with major phrase boundaries as determined by the analysis. This result was determined by a consultant to the experiment who performed an immediate constituent analysis on Passages II and III, bracketing the syntactically significant substrings of each sentence. There was an average of 2.7 parentheses between words within chunks and 5.9 parentheses between chunks on Passage II and the two values for Passage III were 2.7 and 6.2 respectively. For the NEWSPAPER format, the number of parentheses between words within lines was 3.5 and between lines was 3.3 for Passage II and 3.7 and 3.0 respectively for Passage III. (Note: Parentheses delineate boundaries.)

Design. Table 5 presents the experimental design for the study. All Ss were administered Form A, first, in a conventional format as a practice test. Then, Group 1 received the experimental test in the CHUNKED format, Group 2 in the NEWSPAPER format, and Group 3 in the NO CAPITALIZATION format.

Table 5

Experimental Design for Study III

	Practice Test	Experimental Test
Group 1 (N = 30)	Conventional Form A	CHUNKED Form B
Group 2 (N = 30)	Conventional Form A	NEWSPAPER Form B
Group 3 (N = 10)	Conventional Form A	NO CAPITALIZATION Form B

Instructions. Each S was given the following printed instructions and information by the MTA Scholar: (a) 6 min. would be allowed to read all seven passages, (b) there was no time limit for answering questions, (c) most Ss would not be able to finish the test, (d) S should not read so slowly that the questions answered were all correct, but a low score was obtained because so few passages were read, (e) S should not read so fast that many questions were answered, but few were answered correctly since the passages were skimmed over, (f) a $.05 bonus would be given for each correct answer, (g) the Rapid Rater would be used to inform S of the correctness of each answer immediately after the choice had been made, (h) S should not rush through the test hoping to maximize the total score by attempting more questions, since after the 6 min. time limit was up S would be able to attempt all the remaining questions on the test even though S had not been permitted to read the passages, (i) S was instructed about the nature of the passage lengths and number of questions and was permitted to read one passage and answer its questions for practice, and (j) S would take two complete tests with a short break in between.

Ss were not informed that the first test was, from the experimenter's point of view, a practice test. That is, nothing was told S to suggest that both tests were not equally important. E graded the answer sheet after the first test and before starting the second test E informed S of the number of correct answeres and the dollar amount of bonus earned.

Variables. The reading rate variable was expressed in words per minute (wpm). It was calculated by dividing the number of words in the completed passages by the time taken to read these passages. The comprehension score was the total number of questions answered correctly on the completed passages. The passage that was being read at the end of the 6 min. was excluded from the word count and reading time. For the comparisons among different types of readers, a reading accuracy score was constructed by dividing an adjusted comprehension score by the total number of questions attempted on the completed passages. The adjusted score was computed by the following scoring formula: the number correct minus one-fourth the number wrong.

Results and Discussion. Table 6 contains the means and standard deviations of the reading rate and comprehension scores for the three formats, CHUNKED, NEWSPAPER, and NO CAPITALIZATION. Notice that there was no important (or statistically significant) difference between the CHUNKED and the NEWSPAPER formats either on the reading

rate or comprehension variable. However, the NO CAPITALIZATION format decreased the reading speed by 14%. The mean comprehension score for this format was also lower. As compared to the NEWSPAPER format, the decrease in reading rate and comprehension scores for the NO CAPITALIZATION format were both statistically significant ($p < .05$).

Table 6

Reading Rate and Comprehension Means

and Standard Deviations for the

CHUNKED, NEWSPAPER, and NO CAPITALIZATION Formats

	Reading Rate (wpm)		Comprehension (number correct)	
Format	Mean	S.D.	Mean	S.D.
CHUNKED (N = 30)	291	58	18.7	4.4
NEWSPAPER (N = 30)	292	59	19.9	4.5
NO CAPITALIZATION (N = 10)	250	41	16.0	2.4

The study did not produce evidence which would suggest that chunking reading material would increase the reading speed or reading comprehension of mature readers.

In order to investigate the possiblity that chunking does help a certain type of reader, the data was analyzed for interactions. The reading rate scores for the 60 Ss in Groups 1 and 2 were split at the median to produce two groups, termed Fast and Slow. For both the Fast group and the Slow group, the NEWSPAPER format was slightly superior on both the comprehension and accuracy measures. Next, the accuracy scores for these 60 Ss were split at the median to produce two groups, termed the Accurate group and the Inaccurate group. For reading rate or reading comprehension there was no important (or statistically significant) difference between the two formats in either the accurate group or the inaccurate group. Table 7 presents the mean reading rate and accuracy scores for the Fast and Slow, and Accurate and Inaccurate readers.

Table 7

Mean Reading Rate and Accuracy Scores for

Fast and Slow, and Accurate and Inaccurate Readers

	READING RATE				READING ACCURACY			
	FAST		SLOW		ACCURATE		INACCURATE	
	Chunked	News-paper	Chunked	News-paper	Chunked	News-paper	Chunked	News-paper
Reading Rate (wpm)	339	341	242	242	305	300	279	277
Reading Comprehension (number correct)	21.2	22.3	16.3	17.5	22.3	22.2	15.6	15.9
Reading Accuracy (%)	71	76	69	75	84	84	58	61

There is no evidence in Table 7 which would suggest that there is interaction between reading types, i.e., fast and slow or accurate and inaccurate, and the efficacy of chunking. That is, the chunking of reading material does not appear to increase the reading rate or reading comprehension of a mature reader who reads either fast, slow, accurately, or inaccurately.

Although the above analyses were the main analyses of the study, other statistical comparisons were made. Since all Ss in Group 1 and Group 2 did not read exactly the same passages, i.e., the faster readers read some passages not read by the slower readers, the two groups were compared on two passages that all 60 Ss completed. Passages II and III were chosen since not all Ss completed Passage IV, V, VI, or VII and since Passage I, the long passage, might still include some practice or training effect. Table 8 presents the means and standard deviations for the reading rate and comprehension scores on Passages II and III. Notice that there is no important (or statistically significant) difference in reading rate between the formats on either Passage II or III. The CHUNKED format was read slightly faster on Passage II and slightly slower on Passage III. The reading comprehension scores were exactly the same on the two passages. These data further confirm the equality of the two formats.

Table 8

Means and Standard Deviations for the

Reading Rate and Comprehension Scores on Passages II and III

	Passage II				Passage III			
	Reading Rate		Reading Comprehension		Reading Rate		Reading Comprehension	
Format	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
CHUNKED (N = 30)	273	73	3.1	.8	275	66	3.4	.7
NEWSPAPER (N = 30)	269	52	3.1	.8	278	75	3.4	.7

In the preceeding analysis presented in Table 8, possible passage differences were controlled by comparing reading rate and comprehension scores on two passages that all Ss had completed. Although the reading comprehension means on both passages were exactly the same, there was variation in the comprehension scores around the mean. Thus, as a final statistical analysis, the reading rate scores of those Ss who had exactly the same comprehension scores were compared for Passages II and III. Table 9 presents the mean reading rates for those Ss who answered all four questions correctly and also for those Ss who answered three of the four correctly on both Passages II and III. Notice that in the four comparisons between the CHUNKED and the NEWSPAPER formats, the CHUNKED format was read faster in only one instance and the difference was very small (264 >262). Thus, there appears to be no evidence in these data which would suggest that a chunked format can be read at a rate faster than the NEWSPAPER format without loss in comprehension.

Table 9

Mean Reading Rates for the

Four and Three Correct Groups on Passages II and III

	Passage II		Passage III	
	Number Correct		Number Correct	
Format	4	3	4	3
CHUNKED	274 (N = 9)	271 (N = 15)	264 (N = 17)	272 (N = 9)
NEWSPAPER	284 (N = 10)	279 (N = 13)	262 (N = 16)	289 (N = 10)

DISCUSSION

None of the three studies produced evidence that the spatial separation of reading material into meaningfully related groups of words (chunks) improves the reading efficiency of mature readers. Furthermore, there was no evidence which would suggest that a mature reader would benefit from the chunking of material whether he is fast, slow, accurate, or inaccurate. This finding of no difference resulted even though the following conditions prevailed: (a) the subjects were representative of the sample of mature readers to which it was desirable to generalize, (b) the nature of the reading passages was representative of the level of difficulty to which it is desirable to generalize, (c) the format which failed to elicit more efficient reading was a format for which subjects had previously expressed a preference, (d) the motive-incentive conditions, whereby the subjects were paid for correct answers to comprehension questions, most likely yielded a motivation condition similar to the reading situation to which it is desirable to generalize, (e) the test preceeding the experimental test probably minimized the training or practice effects during the experimental conditions, (f) the strategy employed by subjects wherein they were rewarded for maximizing the amount of information during a fixed period of time was representative of the situation to which it is desirable to generalize, and (g) the number of subjects used was sufficient to show statistically significant differences for a format which was known to produce a decrement, yet no advantage was apparent for the experimental format.

These results are apparently in conflict with those of North and Jenkins (1951) who found an advantage for the chunking of reading material. However, the mean reading rates which they reported ranged between 416 and 495 words per minute. At this average rate the behavior of many of their subjects could be described more accurately as skimming and not reading. Further support for this interpretation comes from the relatively low mean scores on the 23 item comprehension test (range: 7.3-8.6). Thus, it appears that the conflicting results are more apparent than real; i.e., chunking may improve skimming.

These findings do not conflict with those of Graf and Torrey (1966) who forced their subjects to read at a rate faster than their normal rate and found that the chunking of the reading material improved comprehension scores. Neither do these results necessarily imply that certain types of readers (e.g., those with perceptual difficulties, or those very slow, or those who are still learning to read) will not

benefit from chunking. Furthermore, the results do not conflict with the other results discussed in the introduction where it was found that chunking facilitated the free recall of sentences (Epstein, 1967) and the rote memorization of passages (Anglin & Miller, 1968). These findings further amplify the important difference between the skills and activities involved in normal reading by mature readers and those skills and activities involved when reading at a rate faster than normal, when recalling sentences, and when memorizing passages.

Although the results of this study are not directly generalizable to the spatial separation of reading material by an immediate constituent analysis, the experimental materials were shown to have much in common with immediate constituents. Thus, it does not appear likely that the separation of materials using an immediate constituent analysis would produce results different form those of these three studies.

It appears that R. W. Woodworth was probably correct back in 1938 when he contended that reading speed would probably not be increased significantly by any arrangement since reading speed was essentially determined by mental processes, not by visual efficiency.

CONCLUSIONS

After two minor experiments and a thorough major experiment, it appears reasonable to conclude that for mature readers the chunking of reading material does not produce faster reading rates with no loss in comprehension per passage or does not produce higher comprehension scores with no decrement in reading rate. Furthermore, the chunked format does not appear to be beneficial to fast, slow, accurate, or inaccurate readers. Since a format which lacked capitalization or punctuation produced a statistically significant decrement, 14%, in reading speed, the finding of no difference between the chunked format and the conventional newspaper type of format cannot be reasonably attributed to a lack of precision or inappropriateness of the experimental procedures.

These results imply that the spacial separation of reading material, e.g., textbooks, into groups of words will probably not improve the reading efficiency of mature readers no matter what method is used to separate the material.

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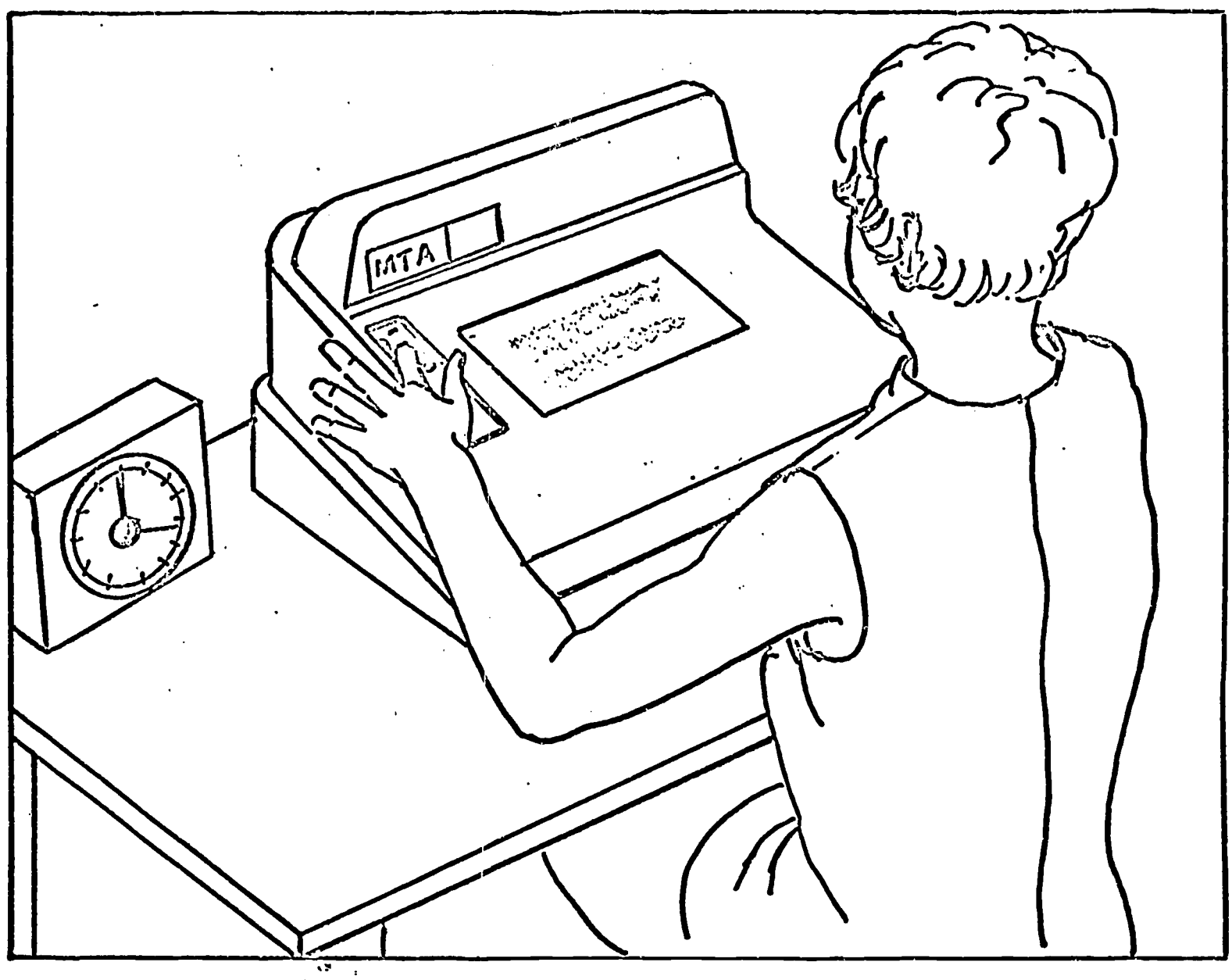
APPENDIX A



EQUIPMENT USED BY EXPERIMENTAL SUBJECTS

APPENDIX B

Examples of the Six Formats Used in Experiment 1

Format A (Conventional)

Assuming that the physical and moral well-being and the stable social order, which are the indispensable conditions of permanent industrial development, are secured, there remains for consideration the means of attaining that knowledge and skill,

Format B (Long Vertical)

Assuming that the physical and moral well-being
and the stable social order,
which are the indispensable conditions
of permanent industrial development, are secured,

Format C (Medium Horizontal)

Assuming that the physical and moral well-being
and the stable social order which are the indispensable conditions
of permanent industrial development are secured,
there remains for consideration the means of attaining

Format D (Medium Vertical)

Assuming that the physical
and moral well-being
and the stable social order,
which are the indispensable conditions

Format E (Short Horizontal)

Assuming that the physical and moral well-being and the
stable social order, which are the indispensable conditions
of permanent industrial development, are secured,

Format F (Short Vertical)

Assuming that
the physical
and moral well-being
and the
stable social order,

APPENDIX C

Form A -- Conventional Format

About three centuries after Homer's time, Greek poets began to discover new kinds of verse, and the way in which poems were made. No one has ever done so much for the poetry we write and read to-day as the singers who sang in the islands of the AEgean Sea and in cities on the mainland of Greece, like Thebes and Athens,

Form B -- Chunked Format

The night was cloudy,
and a drizzling rain,
which fell without intermission,
added to the obscurity.
Steadily, and as noiselessly
as possible,
the Spaniards held their way
along the main street

Form B -- Newspaper Format

The night was cloudy, and a drizzling rain, which fell without intermission, added to the obscurity. Steadily, and as noiselessly as possible, the Spaniards held their way along the main street,

Form B -- No Capitalization Format

the night was cloudy and a drizzling rain which fell without intermission added to the obscurity steadily and as noiselessly as possible the spaniards held their way along the main street