

Readability of Typewritten Material: Proportional Versus Standard Spacing

Donald E. Payne

To what extent do differences in the spacing and width of characters affect the readability of typewritten materials? Reading speed and comprehension scores were compared in two studies; an original experiment and a subsequent replication. Test material consisted of several passages taken from the Davis Reading Test and typed in two versions—one set with proportional spacing (IBM Modern) and the other with standard spacing (IBM Prestige Elite). Results showed a significant difference in reading speed in favor of proportional spacing, without loss in comprehension. There was also evidence of an interaction between passage-difficulty and character spacing, which suggests that reading speed measures may underestimate real differences in readability if comparisons are based solely on simple or familiar material.

Typewritten materials account for a substantial share of the written communications in contemporary society. This would include, for instance, virtually all formal correspondence, most reports (including many of those which may at some later date find their way into print), business and government contracts, proposals, etc. Despite the importance of typewritten materials, a review of the literature failed to uncover published studies which could provide a direct answer to the question: To what extent do differences in the spacing and width of typewritten characters affect the readability of typewritten materials? Consequently, a research project was designed to try to find some answers.¹

There has, of course, been a substantial volume of research on typog-

¹ Financial support of this research was provided by the Office Products Division, International Business Machines Corporation. I am grateful to the Psychological Corporation for permission to reproduce portions of the Davis Reading Test for the purpose of this research. I also wish to express my appreciation to Peter Golding for his invaluable assistance in collecting and analysing the data for this research.

raphy. Much of the research has been concerned with the *legibility* (i.e., ease with which one letter or numeral can be distinguished from others) of different typeface styles and different proportions of height, width, and stroke-thickness.² A smaller share of the research has been devoted to studies of the *readability* (i.e., ease of recognition of groups of letters forming words, phrases, and sentences) of various typefaces.³ The remainder of the research has been concerned with specialized problems, such as the design of alphanumeric characters of high "visibility" for aircraft and radar displays,⁴ or the selection of typefaces which are esthetically pleasing or which seem "appropriate" for different types of editorial material.⁵

The reported research, however, has compared typefaces commonly used in printing, and not typefaces commonly used in typewriters. The present study was designed specifically to investigate differences in readability between two typewriter typefaces, both produced by International Business Machines Corporation: (1) Prestige Elite, a standard typewriter face with all characters designed to one basic width; and (2) Modern, a proportionally-spaced typewriter face with characters designed to four different widths. Samples of typed material for each are shown in Figures 1 and 2.

The individual characters in each of the two typefaces are identical in height; they differ in letter-width, letter-spacing, and word-spacing. It should also be noted that the two faces have been designed for different line spacing. Prestige Elite has a line depth of 12 points; Modern, a line depth of 14 points. These differences constitute what IBM refers to as proportional spacing.

In the experimental design, the independent variable was represented

² A useful source of references: "Legibility of Alphanumeric Characters and Other Symbols: I. A Permuted Title Index and Bibliography," U.S. Department of Commerce, National Bureau of Standards, Miscellaneous Publication 262-1. Washington: Superintendent of Documents, U.S. Government Printing Office, 1964.

³ A useful source of references: Tinker, M. A. *Bases for Effective Reading*. Minneapolis: University of Minnesota Press, 1965.

⁴ The special alphanumeric characters devised for high visibility, such as NAMEL, Berger Numerals, Lansdell Numerals, Mackworth Numerals, etc., have little relevance to reading. Research and examples can be found in McCormick, E. J. *Human Factors Engineering*. New York: McGraw-Hill, 1964; Chapter 6. "Information Displays."

⁵ Zachrisson, B. *Studies in the Legibility of Printed Text*. Stockholm: Almqvist & Wiksell, 1965; especially Chapter 3, "'Congeniality' of Types and Typography."

by proportional and standard spacing. The dependent variable, readability, was measured by reading speed and comprehension.

STUDY I

Method

A total of 190 men and women were tested, using four passages of typewritten material. The passages consisted of four excerpts from the Davis Reading Test.⁶ Each passage was followed by a series of multiple-choice questions to test comprehension of the material.

The passages were selected to provide variety of topics at a level of difficulty which was judged to approximate that of various types of business communications. That is, the sample included material similar to that which might be found in technical reports, descriptions of company procedures, and routine correspondence.

Each passage and each series of questions was typed on a separate page. Two versions were typed—one set with proportional spacing (Modern) and the other with standard spacing (Prestige Elite). Sample pages were printed and carefully matched for quality and blackness of impression. The two sets were identical in format, i.e., same number of words per line, same number of lines, same hyphenation for broken words at the end of a line, etc. In other words, except for the inherent differences between proportional and standard spacing, the two sets of material were exact duplicates.

Testing Apparatus

The A.M.O. apparatus (Appareil à Mesure d'Observation) is a device resembling a large loose-leaf, spiral-bound book. As the pages of the book are turned, a set of stopwatches mounted in the back of the book are actuated by a mechanical linkage. These stopwatches record, to the nearest tenth of a second, the length of time a page is exposed to the reader's view.⁷

The four typed passages were inserted in pages of the A.M.O. appa-

⁶ The specific passages were: "Finland" (346 words Form 1-A, 8 questions), "Marston" (324 words, Form 1-C, 6 questions), "Sponges" (368 words, Form 1-B, 7 questions), and "Economics" (228 words, Form 1-C, 6 questions). Passages are untitled in test. Titles listed are merely for identification.

⁷ The A.M.O. apparatus was originally developed by Marplan, France.

A study has been made by a group of economists of the impact of federal, state, and local taxes on the individual family, including not only income taxes but all others, from sales taxes and customs to the corporation profits tax. It shows that our tax structure is not nearly so progressive as has been claimed. (A progressive tax is one in which the rate goes up as the income increases; a regressive tax, on the other hand, takes a larger proportion of the income of poor families than of rich families.)

These are the conclusions:

- 1) The lowest income group -- those families earning up to \$2,000 per year -- pay 27% of their income in taxes; the highest income group -- those earning more than \$10,000 -- pay 41% in taxes.
- 2) The federal taxes alone are slightly more progressive -- ranging from 16% to 33% for these two groups -- but state and local taxes are actually regressive.
- 3) Despite the progressive federal income tax, the average family earning \$3,000 pays almost as large a portion of its income in taxes (all taxes) as the family earning \$10,000: 28% versus 32%.

The analysis did not support the oftmade assertion that the present tax rates harm investment. On the contrary, the large investor is probably the chief beneficiary of preferential tax treatment.

Figure 1. One of the passages ("Economics") used in both Study I and Study II—
composed in IBM Modern, a proportionally-spaced typewriter face with characters
designed to four different character widths.

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Figure 2. The same passage as Figure 1—composed in IBM Prestige Elite, a standard typewriter face with all characters designed to one basic width.

ratus. The subjects were told that the purpose of the experiment was to measure the difficulty level of a series of passages for an adult reading test. Each individual who participated in the experiment was instructed to open the book to the first passage, read it as he ordinarily would if he came across it in a magazine, then turn the page and answer the multiple-choice questions about the passage. He was further instructed not to turn back to the passage at any time (if this were done, the stopwatch would be actuated again). The experimenter remained in the room observing the experimental subjects to discourage deviation from the desired procedure. In those few cases where subjects failed to follow procedure, their results were excluded and new subjects were recruited. The length of time that each passage was exposed to the view of the subject was recorded. This time record, together with the answers to the multiple-choice questions for each passage comprised the basic data of reading speed and comprehension.

Because the number of words per passage varied, the elapsed time of exposure for each passage was divided into the number of words per passage to produce the reading speed score: *Words-per-minute*.

Comprehension was measured for each passage by dividing the number of questions correctly answered by the total number of questions for that passage to produce the reading comprehension score: *Percent correct*.

Experimental Controls

Individuals differ in reading skill. Consequently, the experiment was designed so that each individual would, in effect, serve as his own control. That is, each individual would read two passages typed with proportional spacing (P) and two typed with standard spacing (S). This in turn meant that two series of passages had to be used, as follows:

<i>Series A</i>		<i>Series B</i>	
Finland	(P)	Finland	(S)
Marston	(S)	Marston	(P)
Sponges	(P)	Sponges	(S)
Economics	(S)	Economics	(P)

Subjects

The sample of subjects for this experiment consisted of 190 men and women recruited from passers-by in a shopping center. Recruiting was

limited to adults who were employed full time. The recruiting procedure was intended to produce a sample of adults which could be expected to be reasonably heterogeneous with respect to common demographic variables. The demographic characteristics of the sample are shown in Table I.

TABLE I. *Demographic Characteristics of Sample: Study I*

<i>Characteristic</i>	<i>Men</i>	<i>Women</i>	<i>Total</i>	<i>Characteristic</i>	<i>Men</i>	<i>Women</i>	<i>Total</i>
<i>Age</i>				<i>Income</i>			
21 to 25 years	44	65	109	Under \$5,000	6	11	17
26 to 35 years	25	7	32	\$5,000 to \$9,999	41	31	72
36 to 45 years	15	13	28	\$10,000 to \$14,999	34	30	64
46 to 55 years	9	9	18	\$15,000 to \$19,999	9	13	22
56 years and older	2	1	3	\$20,000 or more	3	9	12
				Refused	2	1	3
<i>Education</i>				<i>Occupation</i>			
Completed high school	25	52	77	Clerical	14	44	58
Some college	28	14	42	Sales	18	12	30
College graduate	31	11	42	Teacher	7	17	24
Graduate or professional	10	7	17	Engineer	12	1	13
Other/Refused	1	11	12	Manager	4	2	6
				Professional	18	9	27
				Other	22	9	31
				Housewife	—	1	1

Results

Mean scores for reading speed and comprehension are shown in Table II. The figures presented in the table reveal small differences in favor of proportional over standard spacing, which did not achieve statistical significance.

TABLE II. *Mean Reading Speed and Comprehension Scores: Study I*

<i>Measure</i>	<i>Proportional Spacing</i>	<i>Standard Spacing</i>	<i>t</i>	<i>p</i>
Reading Speed (Words per minute)	185	179	1.67	.10
Comprehension (Percent correct)	43	40	1.67	.10

Note: Significance of differences was computed using the formula for difference of correlated means (Walker and Lev, 1953). A two-tailed test was used.

Mean scores for reading speed and comprehension for "hard" and "easy" passages are shown in Table III. The "hard" passages ("Sponges" and "Economics") were more complex, technical selections; the "easy" passages ("Finland" and "Marston") were simpler, essentially narrative and descriptive selections. None of the differences was statistically significant.

TABLE III. *Mean Reading Speed and Comprehension Scores for Hard and Easy Passages: Study I*

<i>Passage</i>	<i>Reading Speed</i>		<i>Reading Comprehension</i>	
	<i>Proportional Spacing</i> (Words per minute)	<i>Standard Spacing</i>	<i>Proportional Spacing</i> (Percent correct)	<i>Standard Spacing</i>
Hard	164	162	43	40
Easy	171	158	42	41

Discussion

Although the observed differences did not achieve statistical significance, the direction of the differences favored proportional spacing. Moreover, the passages in which proportional spacing appeared to increase speed of reading were those in which there was the least difference in comprehension; whereas when proportional spacing made the least difference in speed, there appeared to be a slight gain in comprehension.

Although the numerical differences obtained were rather slight, their pattern thus suggested that the difficulty level of the materials may differentially affect the outcome of the comparisons. The results of this study showed a considerable amount of overlap between performance on the hard and easy passages. Evidently the "hard" passages were not really a great deal harder than the "easy" ones. Since it was not possible to determine from this whether the easy passages had been too hard or whether the hard passages had been too easy, it seemed desirable to replicate the study using a broader range of difficulty from "very easy" to "very hard" passages. To accommodate this expanded range it was decided to increase the number of paragraphs from four to six. The results of the replication are reported in Study II.

STUDY II

Method

The procedures employed in Study II were essentially identical to those

from Study I. However, because of the inclusion of a larger number of passages, it was necessary to use a somewhat more complicated order of presentation.

The passages consisted of six excerpts from the Davis Reading Test.⁸ Six orders of presentation were used. These orders were arranged so that each passage appeared in each possible position (i.e., first, second, third, etc.) at least once. Within each order of presentation, half the passages were typed with proportional spacing and half with standard spacing, in counterbalanced order.

A total of 198 men and women were tested. As in Study I, the sampling procedure consisted of recruiting adult passers-by from a suburban shopping center. The demographic characteristics of the final sample are shown in Table IV.

TABLE IV. *Demographic Characteristics of Sample: Study II*

<i>Characteristic</i>	<i>Men</i>	<i>Women</i>	<i>Total</i>	<i>Characteristic</i>	<i>Men</i>	<i>Women</i>	<i>Total</i>
<i>Age</i>				<i>Income</i>			
21 to 25 years	27	46	73	Under \$5,000	2	10	12
26 to 35 years	33	24	57	\$5,000 to \$9,999	35	30	65
36 to 45 years	19	19	38	\$10,000 to \$14,999	46	31	77
46 to 55 years	16	6	22	\$15,000 to \$19,999	11	13	24
56 years and older	4	3	7	\$20,000 or more	6	4	10
Refused	1	—	1	Refused	—	10	10
<i>Educational</i>				<i>Occupation</i>			
High school graduate	20	36	56	Clerical	6	38	44
Some college	26	32	58	Sales	24	12	36
College graduate	32	17	49	Teacher	6	15	21
Graduate study	22	13	35	Engineer	19	—	19
				Manager	20	4	24
				Professional	23	21	44
				Refused	2	—	2
				Housewife	—	8	8

In both studies, the sampling procedures produced fairly heterogeneous groups of adult subjects. However, there were some significant differences in the demographic composition of the two samples. The

⁸ In Study II, one of the easy passages ("Finland") and one of the hard passages ("Economics") from Study I were used again. Two passages were added which were judged to be even easier than "Finland"—"Waldo" (366 words, Form 2-B, 11 questions), and "Johnson" (253 words, Form 1-C, 7 questions). Two others were added which were judged to be even harder than "Economics"—"Clocks" (334 words, Form 2-A, 10 questions), and "Lacquer" (236 words, Form 1-C, 10 questions).

subjects in Study II were older (though a majority of the subjects in both studies were under 35 years of age), somewhat better educated, and more frequently employed in managerial, professional, and engineering occupations. The incomes of the subjects in Study II were not significantly different from those of the subjects in Study I.⁹

Results

Mean reading speed and comprehension scores are shown in Table V. Passages typed with proportional spacing were read significantly faster than passages typed with standard spacing. Overall there was a six percent advantage in reading speed for the proportionally spaced passages. Comprehension scores were not significantly different.

TABLE V. *Mean Reading Speed and Comprehension Scores: Study II*

<i>Measure</i>	<i>Proportional Spacing</i>	<i>Standard Spacing</i>	<i>t</i>	<i>p</i>
Reading Speed (Words per minute)	180	170	2.72	.01
Comprehension (Percent correct)	48	49	.14	—

Note: Significance of differences was computed using the formula for difference of correlated means (Walker and Lev, 1953). A two-tailed test was used.

Mean scores for reading speed and comprehension for “hard” and “easy” passages are shown in Table VI.

TABLE VI. *Mean Reading Speed and Comprehension Scores for Hard and Easy Passages: Study II*

<i>Passage</i>	<i>Reading Speed</i>		<i>Comprehension</i>	
	<i>Proportional Spacing</i> (Words per minute)	<i>Standard Spacing</i>	<i>Proportional Spacing</i>	<i>Standard Spacing</i>
Hard	169	151	39	42
Easy	206	202	57	58

Although a specific probability value cannot be assigned to the observed differences, it is interesting to note, in contrast to the findings in Study I, that there was a greater difference in reading speed in favor of proportional spacing for the “hard” passages than for the “easy” pas-

⁹ Demographic distributions were compared by means of a simple Chi-square test for independent samples.

sages. This suggests that proportional spacing increases the readability of "hard" material more than it increases the readability of "easy" material. The hypothesis seems plausible. It has been reported that readers adjust their speed to the difficulty of the material to be read.¹⁰ When the individual is working on a reading test, it seems likely that he will read at the highest rate of speed which he can attain without sacrificing comprehension (knowing that he will have to answer questions about the material after reading it). If this reasoning is correct, then the effect of proportional spacing may be explained as follows:

(1) For difficult material, reading speed is slowed down to permit comprehension. Standard spacing exacts an additional delay because of less rapid recognition (i.e., slower recognition). Proportional spacing does not make the content of the material less difficult to understand, but does reduce recognition time. Consequently, reading speed can be increased without loss of comprehension.

(2) For easy material, comprehension is quite rapid. The words and phrases are familiar and simple. Therefore, recognition time may be quite short, and the advantage of proportional spacing correspondingly smaller than for difficult material.

This interpretation suggests certain predictions which could be tested empirically. For example, if recognition times were measured tachistoscopically for individual words which differ greatly in familiarity, then there should be little or no difference in recognition time for familiar words irrespective of whether they were typed with proportional spacing or standard spacing. However, there should be significant differences in recognition time for unfamiliar words—the unfamiliar words typed with proportional spacing should be recognized significantly faster than the same words typed with standard spacing.¹¹

Discussion

The results of the research suggest some answers about the readability of typewritten material. They also raise some questions. In the first place, there was a significant advantage in reading speed for proportional over

¹⁰ Smith, H., and Dechant, E. V. *Psychology in Teaching Reading*. Englewood Cliffs, N. J.: Prentice-Hall, 1961. Pp. 223–224.

¹¹ I am indebted to Dr. H. A. Schwartz of IBM for pointing out the possibility of testing the interpretation by means of a comparison of tachistoscopic recognition times.

standard spacing of typewritten material, without a loss in comprehension.

The findings also suggest an interaction between passage-difficulty and proportional-vs.-standard spacing, which should be taken into account in future comparative studies. For example, if one tests different character widths and spacing in terms of reading speed on passages which deal only with relatively simple, familiar material, the results may seriously underestimate the readability difference.