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ABSTRACT

This study asked participants to rate models of computer-generated text on the perceived ease with which it could be read and studied. These ratings were submitted to a Q-mode factor analysis to identify the underlying criteria used when the reader/perceiver formed a judgment related to the "study-ability" of the text model. Subjects were undergraduate student volunteers from the University of Nebraska-Lincoln Teachers College. Stimuli were 64 models of computer text designed to use variables that have been studied in both print and CRT legibility research and that are frequently used in text design. The stimuli reflected combinations of six frequently used format variables: leading, directive cues, paragraph indication, hypertext, position of heading, and line length. Subjects performed a Q-sort procedure, sorting the stimuli into seven piles according to the "study-ability factor." They were then interviewed about the criteria used during the task and asked why they rated stimuli as highest and lowest. While conscious of such stimulus characteristics as the presence or absence of directive cues, the length of lines, and double or single spacing, the participants were guided in their judgments by the overall structure, simplicity, and spaciousness of the documents. Twenty-seven references are listed. The experimental stimuli and instructions to subjects are included. (LMM)

CRT Text Layout: Prominent Layout Variables

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Chapter 1

Problem

Legible text, whether presented via paper or Cathode Ray Tube displays (CRTs or VDTs) possesses three qualities: symbol visibility (clarity), symbol recognizability (perceptability), and overall comprehensibility (readability) (Raynolds, 1979). A legible display combines the writing of the author with the screen design skills of the publisher. An author can refer to the rules of grammar, spelling and, usage for assistance in writing an understandable message. However, the publisher lacks the same advantage of formal rules or guidelines when combining the text elements that present the author's writing, using instead a combination of artistic principles, folklore, tradition, and economic restrictions.

Art, tradition, and folklore contribute to an attractive layout which is useful in gaining and keeping a reader's attention. However, attention is only one part of the perceptual process in learning from instructional text. Neisser (1976) describes perception as a cycle where the perceiver reacts to the environment (nominal stimulus) by seeking out meaningful information and integrating that information into an existing schema. Written text presented on a CRT display is a nominal stimulus where reading is the primary means of acquisition. Reading, too, is a continuous cycle that requires attending to a stimulus, encoding the stimulus in a meaningful manner, and linking the meanings with existing knowledge or prior experience (Tinker and McCullough, 1962).

The cognitive link between reading and perception is important because it defines a psychological area that may be used to identify processes used by readers in perceiving CRT text and, it sets as a design objective the accurate translation of a nominal stimulus into an effective stimulus. Text should be formatted in ways that facilitate the total perceptual cycle, not just the attention process. Research aimed at meeting this objective has centered on the visibility and recognizability characteristics of text.

Visibility and recognizability contribute to awareness and encoding. Works by Tinker (1963, 1965) and later updated by Rehe (1979) cover the area of visibility quite thoroughly. These findings are usually widely practiced, since a publisher who does not produce visible materials will not be a publisher for long. Although these same standards are frequently used for CRT text displays, the generalizability of paper standards to the CRT has not been verified. Visibility and recognizability research specific to the CRT has established brightness, contrast, and letter size as well as letter shape and dot matrix size. (See Grabinger, 1984 for a summary of these findings.)

Research aimed at enhancing the comprehensibility of a document has been done with directive cues, chunking, organizers, and text layout. The most successful of this research has been with directive cues finding that directive cues (e.g., underlining, italics, bold type) facilitate certain types of learning under the following conditions: first, the cues must be systematically related to desired outcomes (Crouse and Idstein, 1972 and Anderson and Faust, 1967); second, the cues must be used sparingly to indicate only those ideas which are superordinate (Hartley, Bartlett, and Branthwaite, 1980; Bausell and Jenkins, 1977); and finally, the cues must not inhibit or circumvent the desired processing activities (Anderson and Faust, 1967) by forcing extraneous material to compete with essential material or, by permitting non-constructive responses. Research with directive cues in CRT displays has shown cues are most useful in search and recognition tasks (Christ, 1975, 1977).

Other means of changing the format of text to improve comprehension or reading speed have not been as successful as the use of directive cues. These efforts have included breaking the sentence into chunks, hierarchical indentation, and the use of headings.

The goal of chunking research was to facilitate the connections of meanings among words between the nominal stimulus and the reader's schema. A persistent problem of this research was deciding where to break a sentence into thought units. Several implicit assumptions were made. The first was that each sentence was composed of several ideas, each of which was processed in parts by the individual. Second, it was assumed that all readers chunk in the same way. There is no evidence to support either assumption. It appears, then, that ordinary punctuation supplies all the organization necessary within the sentence. When placed in perspective with the number of combinations of format variables available the chunking change was molecular while the intent of text design is wholistic. (See Grabinger, 1984 for a more detailed treatment of chunking research and a list of pertinent references.)

The inability of chunking to have a significant effect on reading speed or learning led to format changes in paragraph organization. The objective of this research was to let the contours of the text format indicate a hierarchical organization of the information within the paragraph or the page. Frase and Schwartz (1979) and Hartley (1980) suggested that the reader's representation (effective stimulus) of the structure of the text may be made more accurate and effecient if the format of the text (nominal stimulus) also represents that structure. Again, the intent was to make the nominal stimulus look like the unseen effective stimulus; however, neither researcher could reject the null hypothesis.

A third format change that did prove to facilitate learning in search and retrieval tasks and comprehension was the use of headings. Headings were useful written in both statement or question forms and whether embedded in the main body of the text or hanging in the margins (Hartley and Trueman, 1982; Holley, 1981).

In sum, the effort to make the nominal stimulus look like an effective stimulus has not seemed successful because there exists no accurate picture of a universal effective stimulus to imitate. It may vary greatly from individual to individual. Plus, given the cyclical nature of perception it would seem reasonable for the effective stimulus to be in a state of constant change and adjustment. It seems that from the application of directive cues and headings that successful format changes are those that facilitate the reading and perceptual cycles. Headings and cues point up specific items of information for additional processing by the learner. The foundation for a set of format rules may be found in the perception and reading processes that will help publication designers construct text that will externally model appropriate cognitive processes, or ". . . allow the learner to activate appropriate methods independently" (Bovy, 1981, p. 208).

Grabinger (1984) attempted to link publication design research to the perceptual processes of individuals by developing models of computer-generated text with several controlled format variables: leading, left and full justification, the presence of directive cues, the use of hypertext, paragraph indication, and heading location. In a multidimensional scaling study using perceptual sentiments expressed by persons viewing models of computer-generated text on CRTs three dimensions describing the perceiver preferences were found: spaciousness, organization, and structure. Spaciousness refers to designs with a lot of white space and openness. Organization refers designs that looked to be grouped or chunked around ideas. Finally, structure refers to designs that appeared hierarchically structured, using hypertext, directive cues, and headings to indicate the structure and location of information.

However, the study used an incomplete cyclical design for the paired-comparison task. Subjects judged 50% of all the possible pairs of the 16 stimuli. This probably contributed to instability and increased stress within the MDS solution. An analysis of a complete stimulus sample may enhance and refine the definitions of the dimensions.

In light of this analysis, this study proposed to identify criteria used by people who view and make perceptual judgements about models of computer-generated text. To improve on the previous study this study used a complete set of carefully constructed stimuli and factor analysis techniques to analyze the resulting data. The goal was to identify criteria used by reader/perceivers to analyze the apparent effectiveness of several models of CRT screens based common text format variables. These criteria (factors or dimensions) can, in turn, be defined and eventually used as general design variables related to the perceptual/reading process rather than small, narrow typographical variables.

Chapter 2

Methodology

Dependent Variable

Print and CRT research have concentrated on single independent variables, usually using reading speed, recognition, or comprehension as dependent variables. This has contributed to the development of standards for individual variables, but not to guidelines for the combination of those variables. The use of a dependent variable based on judgements or sentiments would permit the use of a multivariate statistical technique, such as factor analysis or multidimensional scaling. The main advantage of a multivariate technique, such as the factor analysis technique used in this study, is the ability to examine a multidimensional variable, such as text format perception, with a unidimensional measurement.

In this case, the dependent variable was a unidimensional measure called "study-ability." "Study-ability" was operationally defined as the rating assigned by participants to models of computer-generated text based on the perceived ease with which a text model could be read and studied as if the model were actual text.

These ratings were then submitted to a Q-mode factor analysis to identify the underlying criteria that were used when the perceiver formed a judgment related to the "study-ability" of a text model.

Research Questions

A series of questions were used as a guide for interpreting the factor analysis data. The fundamental assumption was that some underlying factors, smaller in number than the original set of variables, was responsible for the covariation in the variables. Therefore, a prerequisite for the analysis was that the unidimensional scaling of stimuli represent a multivariate space, leading to the question:

1. Can the multivariate concept of computer-generated text design be scaled by readers on a unidimensional scale ?

After the validity of using factor analysis was established by the presence of significant factor loadings the factors or dimensions were named and conclusions about their attributes drawn. The following questions served as a guide for the process:

2. How many factors or dimensions represent the judgements expressed by the participants?

3. What are the definitions of the dimensions?

4. What implications do the dimensions have for design of computer-generated text presented on CRTs?

Data Gathering Method

Sample

The sample was composed of 31 undergraduate student volunteers from the University of Nebraska--Lincoln Teachers College. Participants were United States citizens between the ages of 20 and 25.

Stimuli

Stimuli were 64 models of computer text (see Appendix A) designed to use variables that have been researched in both print and CRT legibility research and that are frequently used in text design. A method called notation (Twyman, 1981) was used to design the text models. This method prevents contamination from content variables by using "X"s, "O"s, and "I"s to represent written text. The "X" is the basic graphic unit that stands for typographic norm such as the bulk of the copy on a page. The "O" represents a primary variation from the typographic norm including italics, all upper case, bold type, color, headings, or reverse type. The "I" is a tertiary graphic unit used rarely to represent something particularly unique in style. The major benefit of the notation method

> is that it encourages serious thinking about typographic problems in conceptual terms, and independently of problems associated with particular copy or composition systems. (p. 11)

Twyman's standard method was altered slightly in this study. Grabinger (1984) used the standard method of placing "X"s to represent the body of the text without indicating any spaces between words. Spaces were used in this study to make groups of "X"s look more like words in actual text. Comments by participants in the 1984 Grabinger study indicated that the solid block of "X"s may have looked too orderly and unrealistic. The placing of the spaces was determined by taking a piece of actual newspaper text and copying it using only "X"s and spaces.

The stimuli were designed to reflect combinations of six format variables used frequently in publication design (see Table 1): leading, directive cues, paragraph indications, hypertext, position of headings, and line length.

Table 1

Variables Used in Stimuli Design

Leading:	(SS)	single spacing
	(DS)	double spacing
Directive Cues:	(NDC)	no directive cues present
	(DC)	directive cues present
Paragraph Indication:	(IP)	indented paragraph
	(SP)	spaced paragraph
Hypertext:	(NHT)	no hypertext present
	(HT)	hypertext present
Heading Position:	(EH)	embedded headings
	(IH)	isolated headings
Line Length:	(LL)	long (60 character) line
	(SL)	short (40 character) line

Leading (space between lines of text) had two values: single spacing (SS) and double spacing (DS). Kolers, Duchincky, and Ferguson (1981) found that double spacing between lines of text on a CRT marginally increased reading speed over single spacing. However, they also found that reading single spaced text required less occular effort, because more densely packed text requires smaller and fewer eye muscle movements. Grabinger (1984) found that perceivers preferred double spaced text. However, this preference is not clear cut and interacts with line length. Readers often do not mind short lines of single-spaced text (Tinker, 1962). Therefore, the affect of single vs. double spaced text was tested with both short and long lines.

Line length was another variable. Turnbull and Baird (1964) recommend that lines of text be between one alphabet and two and one-half alphabets long. In other words, a line should be about 26 to 65 characters long for a given style and size. Research by Keenan (1981) supports this. Keenan used a computer to determine the optimal line length in terms of "chunks" (meaningful phrase units for different readability levels. Results indicated that line lengths in the vicinity of 45 to 55 characters best maintain the integrity of the greatest number of idea units. Yet, despite this research designers often persist in long lines of text. Text presented on the CRT screen can be made up to 80 characters long. Therefore, the two conditions in this study were set at 60 (LL) and 40 (SL) character lines. Both fall within acceptable standards, yet are easily discriminated from one another.

Directive cues took on two values: either the cues were present (DC) or not present (NDC). Grabinger (1984) found that the presence or absence of directive cues had no affect on preferences expressed by participants. However, directive cues have proved a useful format device when used sparingly and related to desired outcomes. Therefore, cues were added to the stimuli by shading three selected "words" with lines.

Paragraph indication was a fourth variable. Paragraphs were indicated by the use of increased white space (SP) (double or triple spacing between paragraphs) or traditional indentation (IP). Subjects in the Grabinger 1984 study stated that they preferred the increased space method of paragraph indication because, the screen appeared more structured and organized.

Hypertext was a fifth variable indicated by its presence (HT) or its absence (NHT). Heines (1984) recommends the use of hypertext to help keep readers apprised of their location in a lesson, the lesson content, their progress, and essential computer commands (e.g., forward, back, or exit). Hypertext is recommended because CRT text pages are short, change frequently, and the nature of a CAI lesson often prevents easily flipping ahead or backward.

Heading location was the sixth variable used. Headings were either embedded in the text (EH) or isolated in a separate column (IH). The use of headings, particularly in question form, has facilitated learning (Hartley and Trueman, 1982). The location of the headings may affect the appearance of organization and structure of the page (Grabinger, 1984).

The 2 X 2 X 2 X 2 X 2 X 2 design presented 64 possible stimulus screen design combinations. Each page was designed on an IBM PC computer with the Multimate word processor program. The stimuli pages were printed on a dot-matrix printer and then enlarged on a photocopy machine. The enlarged copies more closely resembled the size of a typical CRT screen. After enlargement the stimuli were laminated for durability.

Procedures

1. Subjects were welcomed to the experiment and asked to sit in a chair at a table.
2. The instructions for the procedure (see Appendix B) were then played on a cassette recorder and any questions were answered.

3. Subjects then performed the Q-Sort procedure. They were asked to sort the stimuli into seven piles according to the "study-ability" factor described in the instructions. Four stimuli were placed in Pile 1, 8 in Pile 2, 12 in Pile 3, 16 in Pile 4, 12 in Pile 5, 8 in Pile 6, and 4 in Pile 7. This arrangement approximated a normal distribution. The Grabinger (1984) study found that only a few of the sixteen stimuli used elicited strong feelings, while most were of neutral nature. This study, then assumed that the complete set of stimuli would approximate a normal distribution, with few eliciting strong feelings.

4. After completion of the sorting task the participant was interviewed about the criteria used during the task. Responses were written down by the experimenter. Participants were shown the first pile and asked, "Why did you rate these the highest on the "study-ability" factor?" Then, they were shown their seventh pile and asked, "Why did you rate these the lowest?"

Chapter 3

Results

The experiment produced one group of data which was analyzed by factor analysis techniques and a six-way analysis of variance. The factor analysis produced three significant dimensions or factors labled spaciousness, structure, and simplicity. The results of the ANOVA were used to help interpret the meaning of the factors discovered in the factor analysis.

Data Analysis Procedures

The factor analysis procedures used were alpha factoring techniques from SPSSX (SPSSX, 1983) for a Q-mode factor analysis. The analysis proceeded in 4 stages:

First, a data file was prepared for the alpha factor analysis and the ANOVA. A 31 X 64 cell data matrix of subject ratings of each stimulus, with the stimuli assigned to rows was prepared for the factor analysis. A second matrix with the subjects assigned to rows was developed for a repeated measures ANOVA.

Second, the alpha factor analysis was performed with Varimax rotation. Alpha factor analysis was chosen because it maximizes the similarity among similar thinking subjects (Nie, et. al, 1975).

Third, a factor array procedure using a computer program written by Kramer and Amedeo (1984) was performed using the factor loadings from each subset of subjects that load highly on each main factor. This procedure transformed the raw scores of the stimuli to scores representing the magnitude of the factor loadings for subjects loading highly on that factor. The transformed scores of the stimuli were then used to sort the stimuli according the same scale used by the subjects initially.

Fourth, a six-way, repeated measures analysis of variance was performed on the data using the BMDP (1981) statistical package. Data from the ANOVA were used to aid in the interpretation of the dimensions.

This design provided output that permited discussion about the following:

1. The Q-mode factor analysis yields actual groups of similar thinking individuals;
2. the factor array procedures provide a Q-sort, or perception, of the stimuli associated with every significant factor derived from the factor analysis;
3. a comparison of different group perceptions based on the differences in the factor arrays, or, in effect, differences in the perceptions of the model text designs;
4. and, a picture of the importance of the variables via the analysis of variance.

Factor Analysis Solution

The data matrix submitted for analysis contained the pile number in which each subject placed the specific stimulus. The alpha analysis calculated a correlation matrix between all pairs of subject-sorts and then performed a Q-mode factor analysis to extract groups containing subjects that covaried because of similar Q-sorts (see Table 2). The Q-mode factor analysis is designed to isolate distinctive groups, if such groups exist. Since every Q-sort represented a "study-ability" value perception over the 64 text models, a covariance of Q-sorts is a covariance of similar perceptions. Each significant Q-mode factor should, then, represent a prototypical "study-ability" perception, reflecting the common but not the unique portions of the perceptions of those subjects who load highly on it.

The results of the rotated factor analysis are presented in Table 2 (next page). Significant factors selected for analysis were Factors 1, 2, and 3. Factors 4, 5, and 6 were not considered significant because of the small number of subjects loading significantly (more than .5 variance) on those factors.

Factor Array Procedure

To define the factors it was necessary to take the additional step of creating factor arrays for each Q-mode factor derived in the analysis and considered to be significant. Taking this additional step permitted the discussion of the distinctive types of text design perceptions that potentially exist in the population.

The process of arriving at a Q-sort for a factor or group is analogous to a subject's task of mentally assigning values to text models and then discriminating among the valued text models by sorting. The result is a group Q-sort instead of a single subject

Table 2

Rotated (Varimax) Factor Matrix (>.5 Variance)

Subjects	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
22	.90289					
25	.88960					
1	.82311					
18	.80017					
20	.77836					
24	.73605			.55087		
17	.70320					
5	.69826					
26	-.61377					
15	-.58523					
14	.55164		.52254			
30	.50821					
31		.81175				
3		.77916				
8		.68400				
10		.66538				
27		.58084				
2		.56860				
16			.80607			
11			.76487			
13			.60475			
21			.52238			
9				.72889		
12				.62299		
23			.57278	.57884		
6					.93605	
4					-.53106	
19					.51031	
7						.63307
28						.60481
29						.58716

Table 3

Factor Arrays

Factor 1

1	2	3	4	5	6	7
2 17 20 21	5 6 8 10	1 7 12 14	4 13 16 23	3 9 32 36	11 25 27 35	43 51 59 6
	19 22 26 50	15 18 24 28	29 31 33 37	42 44 46 47	41 45 57 64	
		30 34 40 52	38 39 53 54	48 49 60 61		
			55 56 58 62			

Factor 2

1	2	3	4	5	6	7
1 37 39 47	3 6 15 17	5 12 13 14	4 8 10 11	7 22 27 32	2 9 25 34	16 23 49 5
	18 26 36 62	21 28 30 38	19 20 24 29	40 44 48 50	35 45 52 58	
		41 46 53 64	31 33 42 43	54 60 61 63		
			51 55 56 59			

Factor 3

1	2	3	4	5	6	7
13 38 41 53	1 3 5 18	2 4 12 14	6 8 10 11	9 16 17 22	7 32 43 48	27 34 35 5
	19 26 28 46	20 21 37 39	15 24 25 29	23 31 36 40	55 57 58 63	
		45 47 52 62	30 33 44 51	42 49 60 61		
			54 56 59 64			

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Table 4

Repeated Measures Analysis of Variance

Main Effects (p < .01)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Mean	31720.00454	1	31720.00454	6992498.00
Error	.13609	30	.00454	
Hypertext	373.64970	1	373.64970	21.42*
Error	523.30343	30	17.44345	
Headings	.84728	1	.84728	.07
Error	347.66835	30	11.58894	
Directive Cues	236.50454	1	236.50454	15.28*
Error	464.44859	30	15.48162	
Spacing	64.23841	1	64.23841	4.50
Error	428.65222	30	14.28841	
Line Length	237.88760	1	237.88760	27.55*
Error	259.00302	30	8.63343	
Paragraph	136.81502	1	136.81502	18.82*
Error	218.13810	30	7.27127	

*p < .01

sort using high-loading individuals. Thus, the calculation of the factor's perceived "study-ability" values for all of the text models depends on the prior scores assigned to text models by these high-loading individiuals. The factor arrays are presented in Table 3.

ANOVA

The six-way repeated measures analysis of variance was performed to help shed light on the factor anlysis information. The ANOVA presented differences among four of the six main effects: hypertext, directive cues, line length, and paragraph spacing (see Table 4). CRT screen models with hypertext, directive cues, short lines and, spaced paragraphs were rated higher than models without hypertext or directive cues and with long lines and indented paragraphs.

Factor Definitions

Factor 1. Ten participants had high loadings on this factor, or ten participants used similar criteria when sorting the 64 text models. On the basis of the sorted stimuli, subject interviews, and ANOVA this factor is labled structure. The preferred stimuli appeared more structured, that is, organized and hierarchically arranged than the low rated stimuli. The four highly rated stimuli (Group 1) had hypertext while the four low rated stimuli (Group 7) did not have (see Appendix A for the Group 1 and Group 7 stimuli in each of the three factors). This is consistent with information in the ANOVA where the hypertext condition was rated higher than the no-hypertext condition. Also, all four of the high rated models had the directive cues option, while three of the low rated models did not have directive cues. This also, is consistent with the ANOVA results. The paragraph condition may have contributed to the appearance of structure, too. Three of the highly rated models were the spaced paragraph condition, while all four of the low rated stimuli were the indented paragraph condition. The condition of structure suggests that the high rated stimuli appear organized with clearly marked segments of information, yet related to a major topic.

Factor 2. The highly rated stimuli in Group 1, sorted on Factor 2 seem to be characterized by their simplicity. Three of the top four are double spaced with no complexities introduced from the presence of hypertext, isolated headings, or spaced paragraphs. All appear easy to read from top to bottom and more unified for a simple reading task. The four models from Group 7 are made more complex and less unified by the use of hypertext, isolated headings, or both.

These four stimuli lack the appearance of structure described in Factor 1 and also appear scattered and less easy to read. Simplicity of design was a significant criteria for six subjects who loaded highly on Factor 2.

Factor 3. The distinguishing characteristic between the stimuli in Group 1 and Group 7 seems to be spaciousness for the six subjects who loaded highly on factor 3. Three of the four highly rated stimuli are double spaced with short lines, while all four of the lowly rated stimuli are single spaced and appear jammed-up with text. Although the ANOVA indicated no main effect difference between the single and double spaced models as a whole, this subgroup of participants thought that this was important. This is consistent with subject interviews where 5 of the subjects stated that their main criteria was double spacing within the text.

Chapter 4

Discussion

The use of multivariate techniques in text design and visual problems can provide a great deal of data (see also Grabinger, 1984 and McIsaac, Mosley, and Story, 1984). The value of such techniques derives from the emphasis on the identification of perceptions rather than on the affects of individual text design variables. By the very nature of perception the human being is adaptive. Humans can read easily a wide variety of type styles, type sizes, line lengths, and graphic combinations. Difficulties in reading, searching, or comprehension tasks occur at extremes, such as very small or very large type size, suggesting that there are many combinations of text design variables that may be considered optimal. Techniques such as factor analysis and multidimensional scaling provide a basis for identifying perceptual tendencies or patterns that suggest gidelines for the combinations of text design variables.

The original problem of this study was to identify perceptual judgements expressed by persons viewing models of computer-generated text. The combinations of six CRT design variables, each with two values, seemed to affect three criteria used by participants in making judgements: structure, simplicity, and spaciousness. While conscious of such things as the presence or absence of directive cues, the length of the lines, and double or single spacing, the participants were guided in their judgements by the overall structure, simplicity, and spaciousness of the dr 'ents.

The first criteria discussed was structure. This dimension was also found in the 1984 multidimensional scaling study (Grabinger). Structure refers to designs that indicate a hierarchical arrangement of subject material organized with the use of hypertext, isolated headings, spaced paragraphs, and directive cues. Participants stated that they would prefer to study from text that appears chunked into manageable and organized segments.

The second criteria was the simplicity of a design. If the design did not appear neatly structured the participants preferred a design with few complications. It would seem to suggest that if the design does not appear structured around its subject matter the reader would prefer simple lines of text. No structure would be better than a messy or busy screen.

The third criteria was spaciousness. While a careful and neat structure can utilize single spaced type and long lines, lack of structure will cause a screen design with single spaced type and long lines to be rejected. Yet, given lack of structure, then double spacing is an important criteria. A screen of information should be double spaced, preferably with short (45 character) lines if no other graphic or design features are used to help break the text into manageable chunks of information.

While the use of mulitivariate techniques offer greater sophistication in the exploration of complext topics such as text design, they also require a great deal of data collection. Although this study remedied a fault of a previous study by the use of a complete stimulus sample, there was still the need for more information. A content analysis of participant descriptions of the stimuli as well as an adjective rating of the stimuli could facilitate interpretation of the factors. While two of the factors (structure and spaciousness) were consistent with the factors discovered in the 1984 Grabinger study, one of the factors was different. In the 1984 study the third factor was described as organization, whereas in this study the factor was described as simplicity. It is conceivable that neither is an accurate description and a similar study using adjective scales, content analysis, and structured interviews may help clarify or eliminate that dimension.

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Appendix A

Stimuli

Factor I: Structure

Group 1

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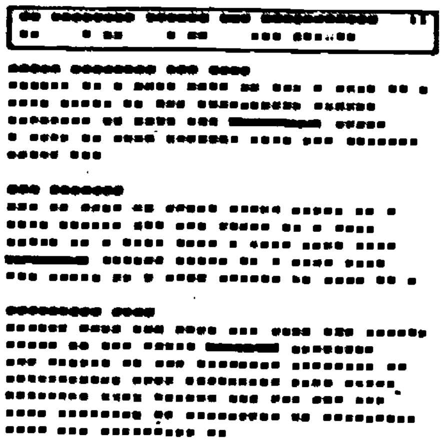

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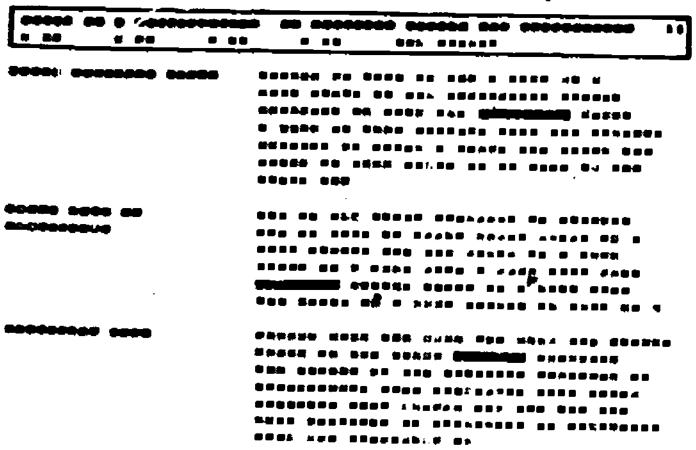

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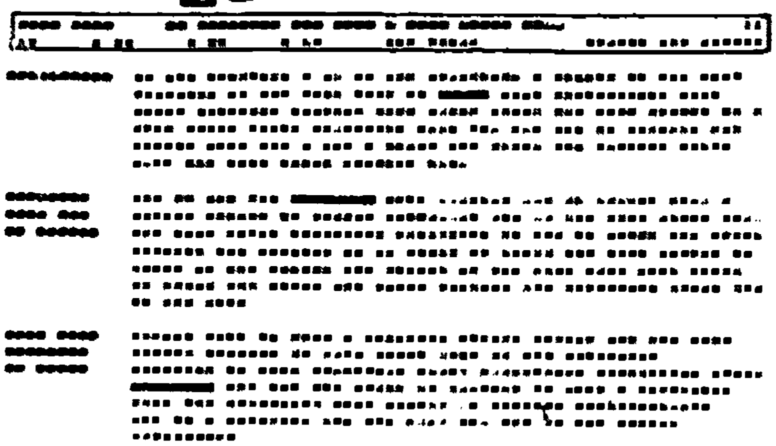

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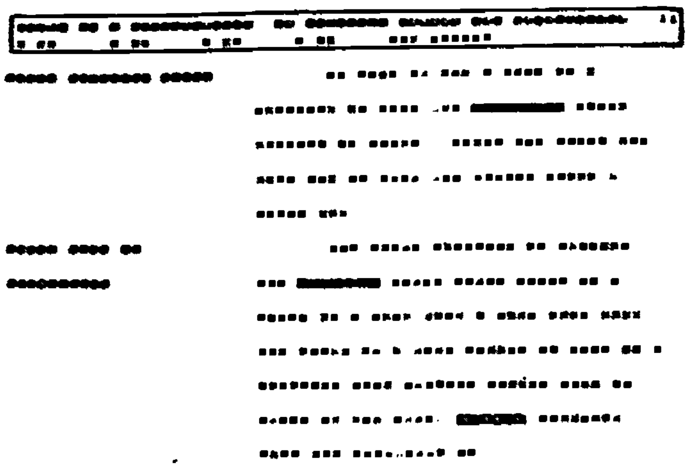

Factor I: Structure

Group 7

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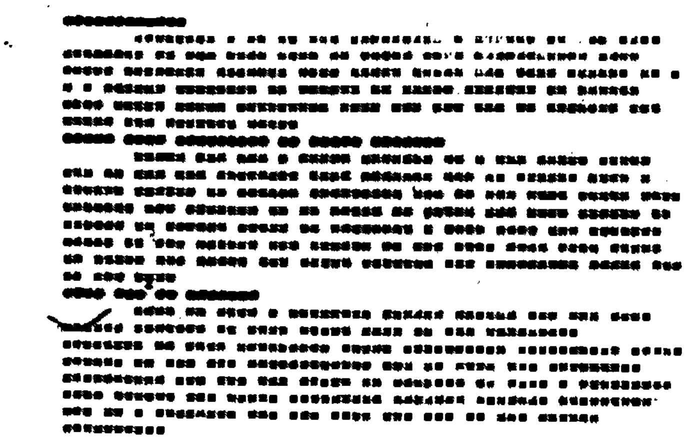

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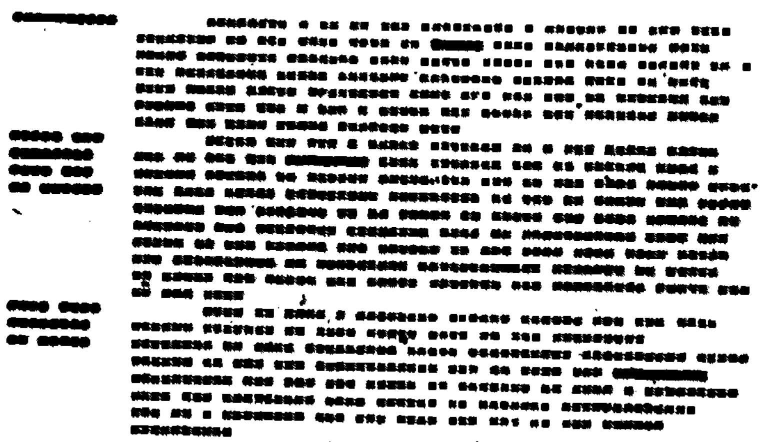

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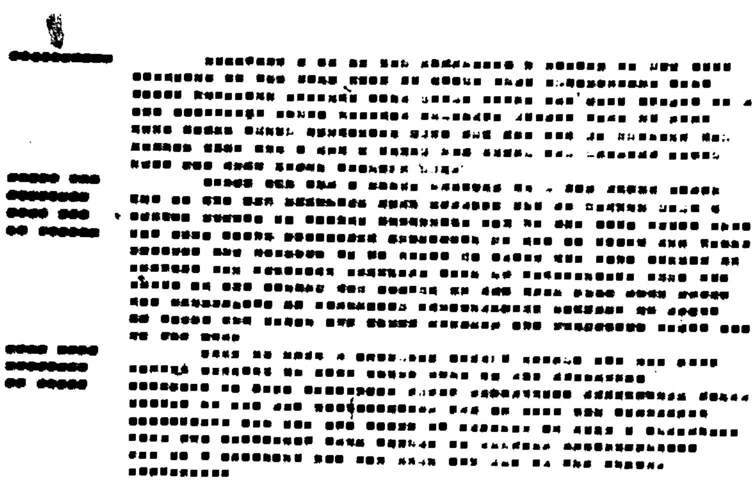

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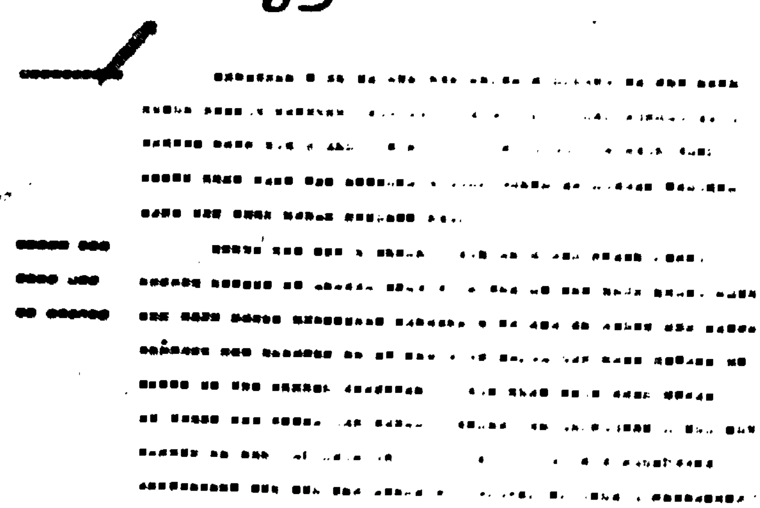
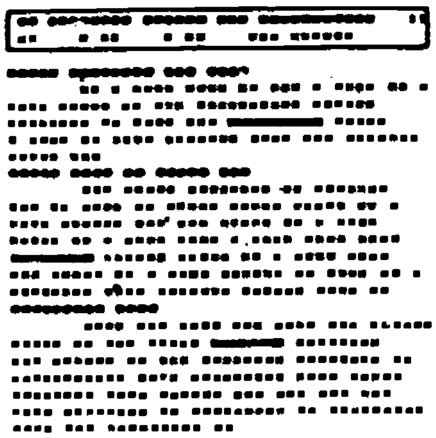


Factor 2: Simplicity

Group 1

1



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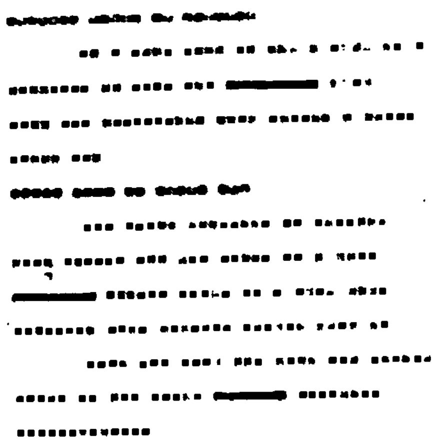

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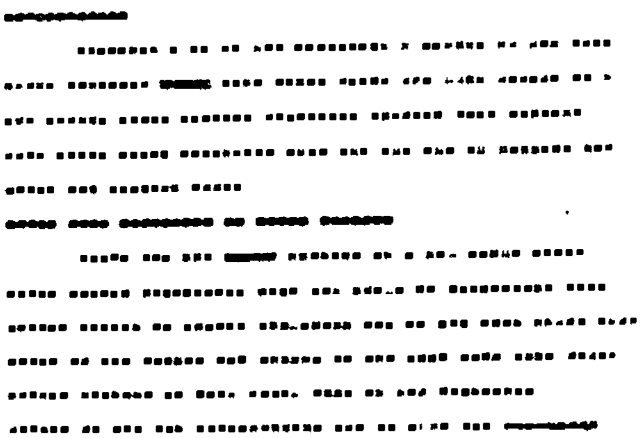

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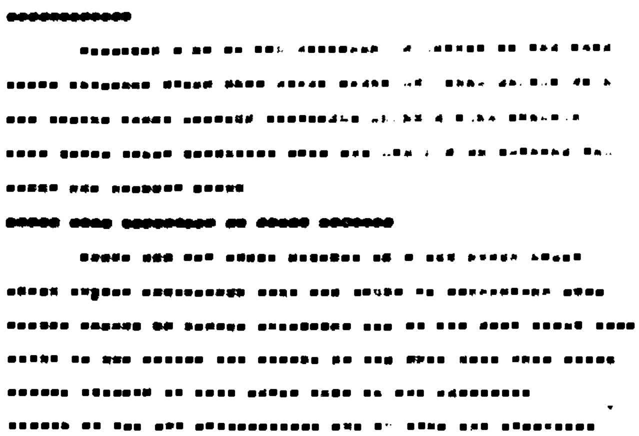
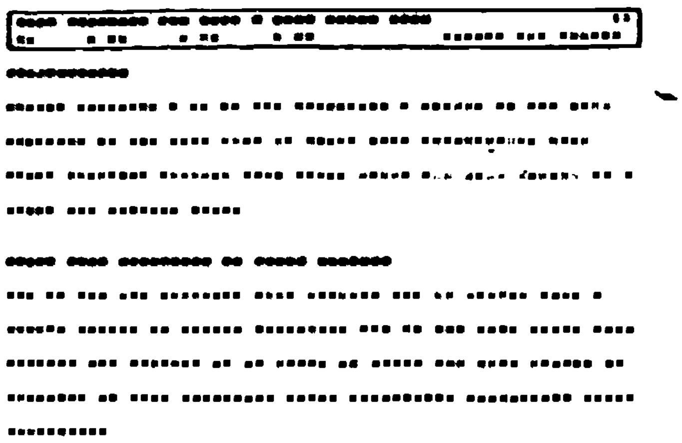


Factor 2: Simplicity

Group 7

16



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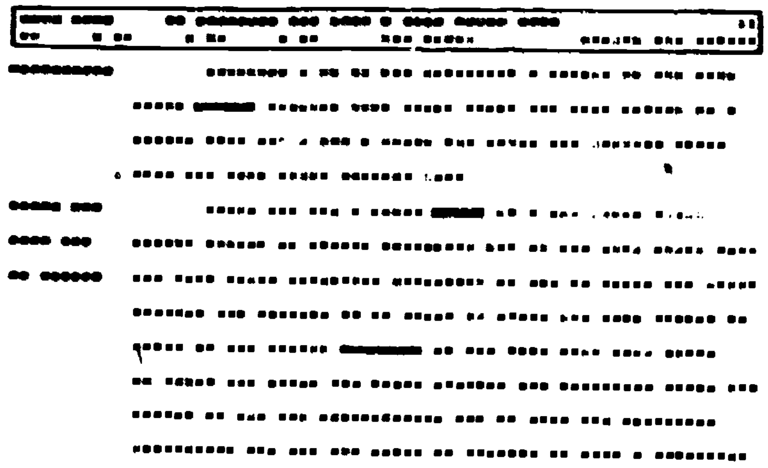

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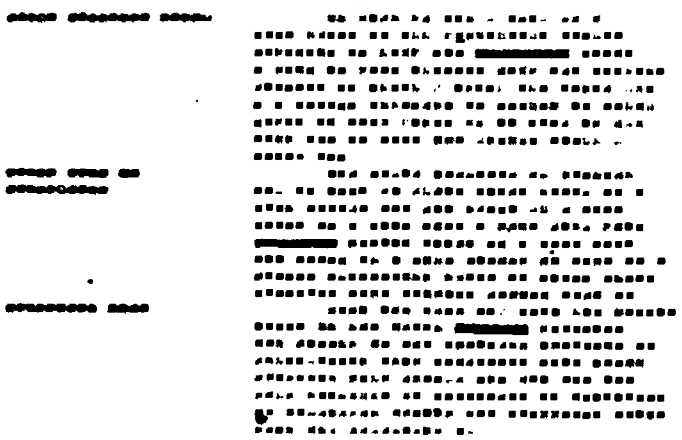

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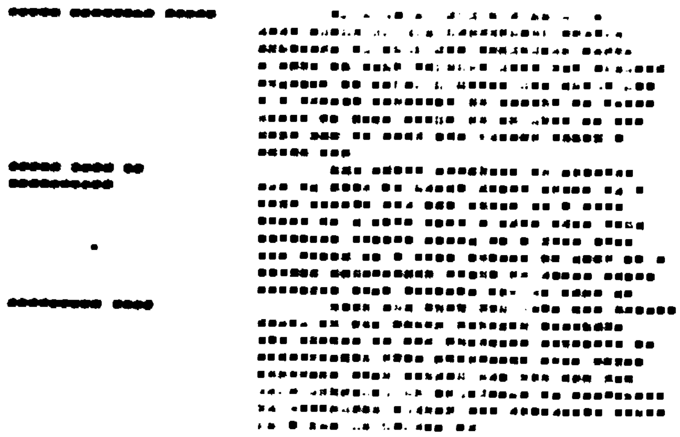
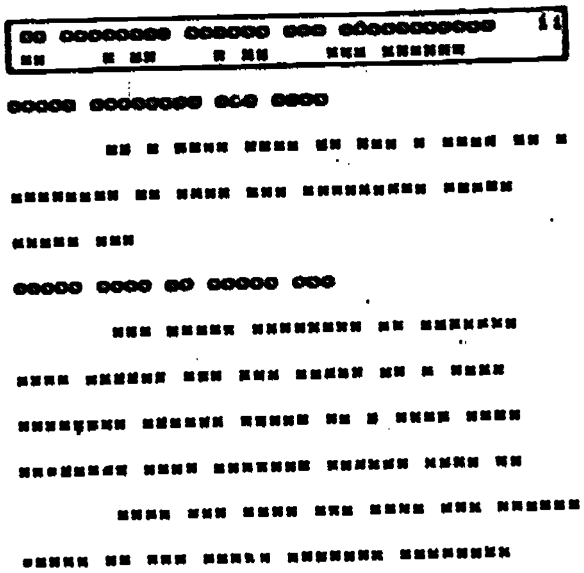


Factor 3: Spaciousness

Group 1

13



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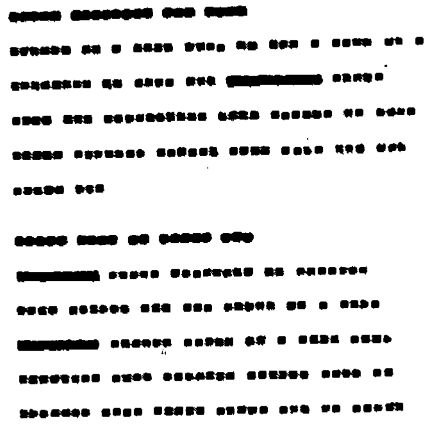

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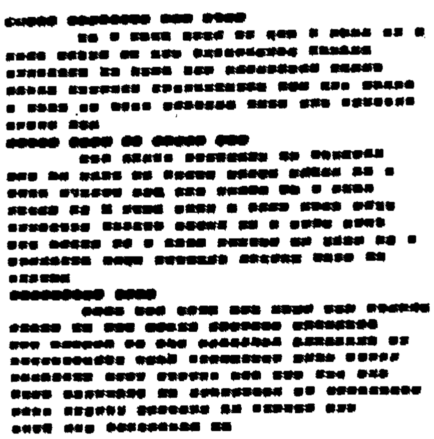

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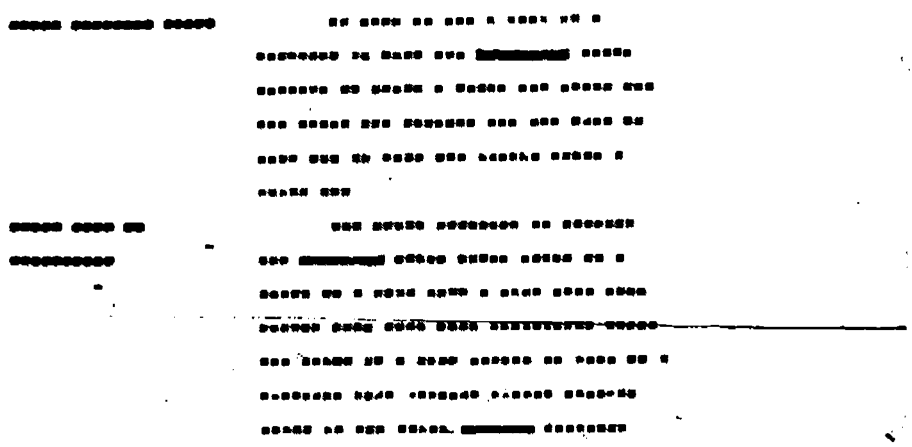
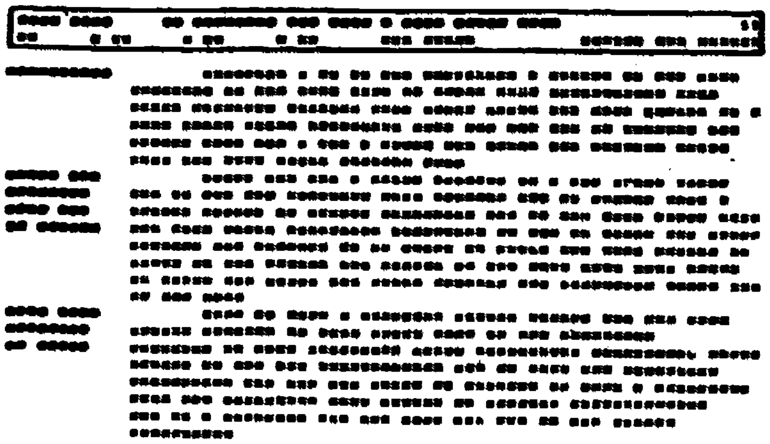


Factor 3: Spaciousness

Group 7

27



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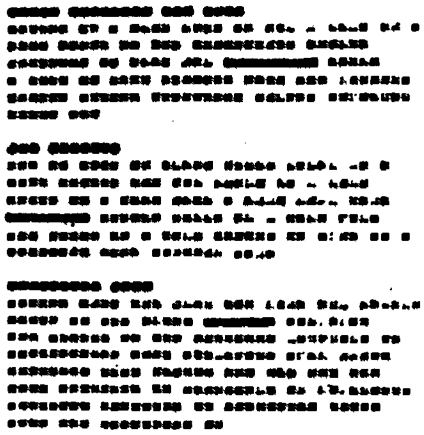

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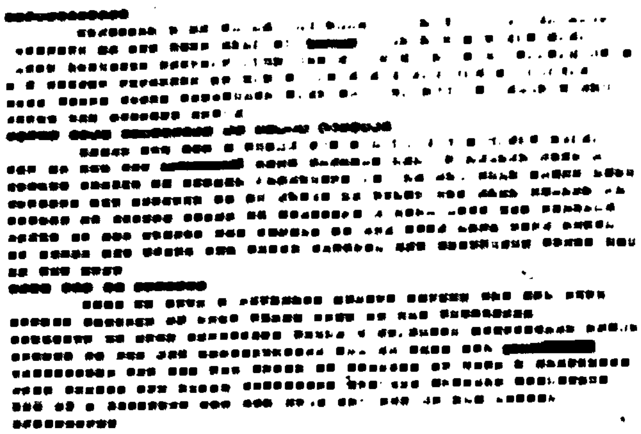

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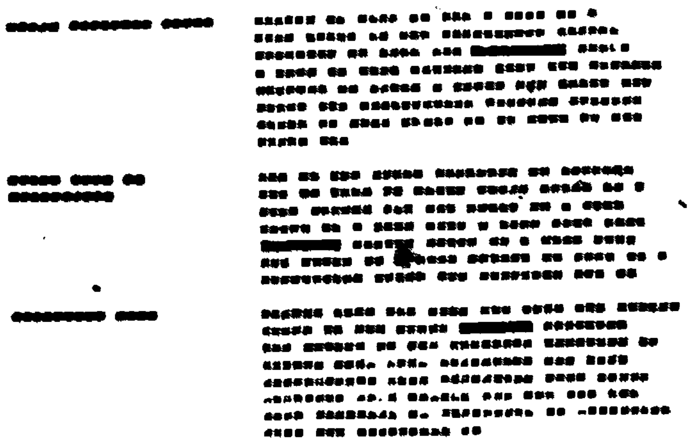

Appendix B
Instructions to Subjects

You will examine several models of computer-generated text. These are models of text that may be seen on computer television screens when using computer-assisted instruction.

Before you begin, look at some of the text models in front of you. Note that they are composed of "X"s and "O"s. The "X"s represent the body of the text. The "O"s represent words that are special, such as headings or subheadings. On some of the models you will see three sets of "X"s that are darker than the rest of the text. These dark sets of "X"s represent words that may be in italics, bold type, or underlined. Finally, some of the models have a box at the top of the page. This box is called hypertext and contains a summary of the content of the lesson and a list of computer commands that may help the learner during the lesson.

When you examine the text models evaluate each model on a factor called "study-ability." "Study-ability" refers to both readability and learning characteristics. For example, a text model with a high "study-ability" factor would appear easy to read and easy to study. On the other hand, a text model with a low "study-ability" factor would appear hard to read and hard to study. You are the judge of what appears easy or hard to read and study. There is no right or wrong answer. The best answer is whatever you decide. Look at each model and ask yourself, "If this were actual text would I find this style easy to read and study or hard to read and study?"

Sort the 64 models of computer-generated text into seven piles according to the "study-ability" factor. Remember to base your judgements on how easy the model appears to study as if the model were actual text. Use the sorting procedure described as follows:

In Pile No. 1, place the 4 text models that have the highest "study-ability" factor. In Pile No. 7, place the 4 text models that have the lowest "study-ability" factor. One way to do this is to go through the text models sorting them into high, medium, and low "study-ability" piles. Then return to the "high" pile and find the four with the highest "study-ability" rating and place them in Pile No. 1. Then, go to the "low" pile and find the four with the lowest "study-ability" rating and place them in Pile No. 7.

After placing models in pile numbers 1 and 7 there will be 56 models left. Place all of the models together and repeat the sorting procedure. Place the 8 with the highest "study-ability" rating in Pile No. 2 and the 8 with the lowest "study-ability" rating in Pile No. 6.

~~Then there will be 40 text models~~ remaining. Place all of the models together again and re-sort them. From these 40 models place the 12 with highest "study-ability" rating in Pile No. 3 and the 12 with lowest rating in Pile No. 5.

There will then be 16 models left and they are all placed in Pile No. 4.

The number of the text models to be placed in each pile also appears on the pile identification cards on the table in front of you. you may rearrange the models until you are satisfied with their placement, but make sure you place the specified number of text models in each pile.

you may refer to these instructions or ask the experimenter for help whenever you wish. Finally, remember to judge each model on how easy it appears to study as if it were actual text.