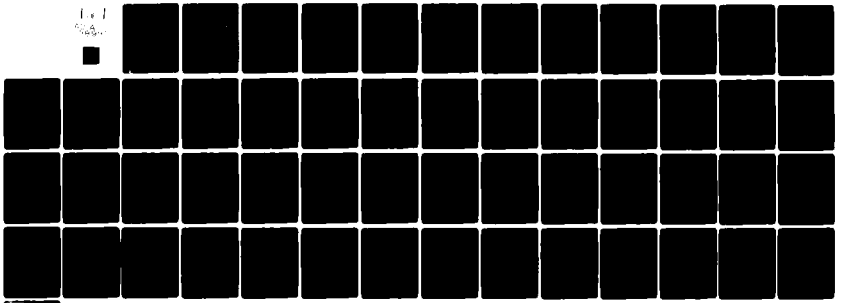
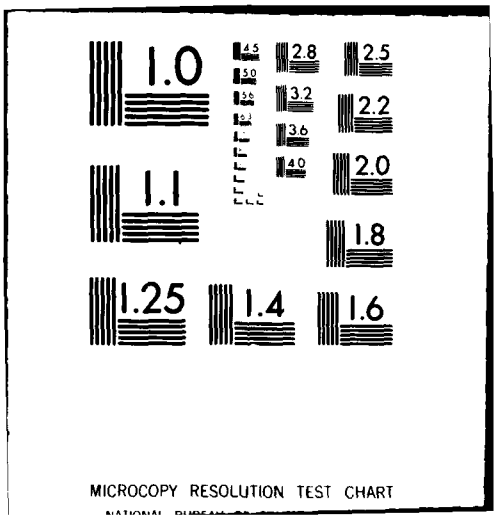
AD-A089 910 ARIZONA UNIV TUCSON DEPT OF PSYCHOLOGY F/G 5/10
ABSTRACTING MAIN IDEAS FROM TECHNICAL PROSE: A PRELIMINARY STUD--ETC(U)
JUL 80 D E KIERAS N00014-78-C-0509
UNCLASSIFIED TR-5 NL



END
DATE FILMED
11-80
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART

12

Abstracting Main Ideas from Technical Prose: A Preliminary Study of Six Passages

David E. Kieras
University of Arizona

Technical Report No. 5
July 30, 1980

This research was supported by the Personnel and Training Research Programs, Office of Naval Research, under Contract Number N00014-78-C-0509, Contract Authority Identification Number NR 157-423. Reproduction in whole or in part is permitted for any purpose of the United States Government.

Approved for Public Release; Distribution Unlimited

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(16) RR042-06

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Report No. 5
2. GOVT ACCESSION NO.: AD-A089910
3. RECIPIENT'S CATALOG NUMBER:

(6) 4. TITLE (and Subtitle): Abstracting Main Ideas from Technical Prose: A Preliminary Study of Six Passages.

(9) 5. TYPE OF REPORT & PERIOD COVERED: Technical Report. July 30, 1980

6. PERFORMING ORG. REPORT NUMBER:

(10) 7. AUTHOR(s): David E. Kieras

(15) 8. CONTRACT OR GRANT NUMBER(s): N00014-78-C-0509

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Department of Psychology
University of Arizona
Tucson, AZ 85721

(17) 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 61153N; RR 042-06
RR 042 06 02

11. CONTROLLING OFFICE NAME AND ADDRESS:
Personnel and Training Research Programs
Office of Naval Research (Code 458)
Arlington, VA 22217

(11) 12. REPORT DATE: 30 July 1980

13. NUMBER OF PAGES: 53

(14) TR 5

(12) 54

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report): unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Reading, Comprehension, Abstraction

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The construction of the macrostructure, or abstracted main content, for a passage should be based on the semantic content of the passage together with the reader's general knowledge, but guided or influenced by superficial features such as what the initially mentioned information is. Passages were studied that varied in the familiarity of their content, and in their structure according to the macrostructure theory. One type of passage was based on a generalization followed by specific

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

411085

examples; a second type was based on a conclusion followed by a supporting argument. Each passage appeared in either a good version, in which the main idea was explicitly stated in the first sentence, and in a bad version with no explicit statement of the main idea. For each passage, the subjects provided reading times, ratings of the importance of individual passage sentences, and one-sentence statements of the main ideas which were analysed for differences in content. The results show that, in arriving at their statements of the main ideas, readers make use of both semantic and superficial properties of the passage. In particular, they can recognize highly thematic sentences even in unfamiliar material; they make very direct use of explicit statements of the main idea; if the main idea is not explicit, they can infer one if the passage material is familiar; and they can organize even an unfamiliar passage around alternative forms when the main idea is not explicit. An informal process model for the process of abstracting main ideas is presented that summarizes these results.

Abstracting Main Ideas from Technical Prose:

A Preliminary Study of Six Passages

David E. Kieras

University of Arizona

Technical Report No. 5

July 30, 1980

This research was supported by the Personnel and Training Research Programs, Office of Naval Research, under Contract Number N00014-78-C-0509, Contract Authority Identification Number NR 157-423. Reproduction in whole or in part is permitted for any purpose of the United States Government.

Approved for Public Release; Distribution Unlimited

Abstract

The construction of the macrostructure, or abstracted main content, for a passage should be based on the semantic content of the passage together with the reader's general knowledge, but guided or influenced by superficial features such as what the initially mentioned information is. Passages were studied that varied in the familiarity of their content, and in their structure according to the macrostructure theory. One type of passage was based on a generalization followed by specific examples; a second type was based on a conclusion followed by a supporting argument. Each passage appeared in either a good version, in which the main idea was explicitly stated in the first sentence, and in a bad version with no explicit statement of the main idea. For each passage, the subjects provided reading times, ratings of the importance of individual passage sentences, and one-sentence statements of the main ideas which were analysed for differences in content. The results show that, in arriving at their statements of the main ideas, readers make use of both semantic and superficial properties of the passage. In particular, they can recognize highly thematic sentences even in unfamiliar material; they make very direct use of explicit statements of the main idea; if the main idea is not explicit, they can infer one if the passage material is familiar; and they can organize even an unfamiliar passage around alternative forms when the main idea is not explicit. An informal process model for the process of abstracting main ideas is presented that summarizes these results.

Acknowledgements

Thanks are due to Susan Bovair, Mark Stempski, Jim Lentz, and Kathy Warrick for their valuable and enthusiastic assistance in the long and tedious process of collecting and analyzing the data described in this report.

Abstracting Main Ideas from Technical Prose: A Preliminary Study of Six Passages

David E. Kieras
University of Arizona

The theory of textual macrostructure proposed by van Dijk (1977a, 1977b) and Kintsch and van Dijk (1978) attempts to describe how readers abstract the gist, or important content, from prose. In this theory, the reader first extracts from the text a set of microstructure propositions that correspond to the directly expressed content of the text, and then constructs a set of macrostructure propositions which in some sense subsume or summarize the microstructure propositions. If the reader's task is to produce a summary, he or she would simply state this macrostructure in the form of prose. If the reader's task is to remember the passage, he or she will give priority in memory encoding effort to the macrostructure propositions over the microstructure propositions that simply supply details. Hence later recall will tend to consist of the passage macrostructure, and so will be highly condensed and concerned with the main points rather than details.

The macrostructure theory can be contrasted briefly with two related notions; schemata (see Kintsch and van Dijk, 1978), and scripts (Schank and Abelson, 1977). In the sense of Kintsch and van Dijk, textual schemata express stereotyped organizational forms, such as the standard plot lines use in stories. Scripts express stereotyped sequences of events, the favorite example being what happens when one enters a restaurant. There seems to be general agreement that the the comprehension of ordinary story-like material should be explainable in terms of script and schema notions. A central feature of these notions is that the reader can comprehend using a "fill in the slots" approach.

However, technical prose does not seem amenable, at first glance, to treatment in terms of scripts and schemata. An obvious counter-example to this claim is that experimental psychologists have a schema for an experimental article, and probably have scripts for various common sequences of events in scientific activities.

However, the key feature of schema and script theories is that the prose material has some stereotyped features. But the most outstanding property of technical prose is that it expresses information that most readers find novel. This seems to be a strong argument against the use of script theory for technical prose. It may be a criticism of schema theory as well. However, there may be standard organizational forms for technical passages of paragraph length, such as the materials used in this work. Whether such standard organizational forms, or schemata, in technical prose have psychological reality for ordinary readers

has yet to be determined. Examples of possible forms that will be considered more below are: (a) a generalization followed by specific examples; (b) a conclusion followed by an argument supporting it; and (c) a sequence of facts leading up to a conclusion or climax.

Even if such organizational forms are present in technical passages, it is not clear that such forms are used in a "fill in the slots" manner. The problem is that the reader has little information before reading the passage about which schema it will follow; only after seeing the relationship between the ideas in the passage could he or she classify the underlying organizational form.

All these considerations suggest that the macrostructure theory may be the most useful current theory to apply to technical prose, since it contains rules for abstracting the important content of the passage without necessary recourse to an organizational schema for the passage. Van Dijk (1977a, 1977b) has proposed macro-rules that generate macropropositions given a passage microstructure and general knowledge. These rules operate on the semantic content of the passage and of long-term memory. Of particular interest here are van Dijk's GENERALIZATION and CONSTRUCTION rules. The GENERALIZATION rule, stated verbally, says that a set of micropropositions can be replaced with a macroproposition whose terms are supersets of the corresponding terms of the microstructure propositions. The CONSTRUCTION rule states that a set of microstructure propositions can be replaced with a macroproposition that either implies or is implied by the micropropositions. Notice that the GENERALIZATION rule, based only on superset relations, seems to be considerably simpler and more clear-cut than the CONSTRUCTION rule. In both rules, it is assumed that the macropropositions could be either expressed explicitly by the passage, in which case the rules operate to select or identify the macropropositions, or only implied by the passage, in which case the rules act to generate the macropropositions, a process which could involve heavy use of long-term memory information.

As presented, the building of macrostructure is based strictly on the semantic content of the passage, together with related semantic information in long-term memory. However, it seems reasonable that surface features of the passage would be important in indicating the important content in the passasge as well. Intuitively, we all know that how we choose to phrase or order the sentences in a paragraph is rather important to whether our reader gets the point. From a linguistic perspective, there are many surface features associated with the assignment of what is relevant anc what is irrelevant in a text (van Dijk, 1979). Finally, there is some empirical work showing that sentence surface structure and the ordering of information in a passage affects the reader's perception of the important content (Clements 1979, Kieras, in press (a), in press (b)). Of particular importance seems to be initial mention. The first-mentioned idea or item tends to be viewed as the passage topic just by virtue of its position (Kieras, in press (a)).

The obvious conclusion to be drawn is that the macrostructure building process operates mainly with the semantic content, but is guided or influenced by surface properties of the passage. Although this is an obvious conclusion, it is not at all obvious how the process actually works. This paper presents some experimental results and an informal model of how the macrostructure building process is guided by the passage surface form, especially the initially mentioned information, but still relies heavily on inference and constructive processes based on general knowledge.

The experimental approach is based on that in Kieras (in press (a), in press (b)). Subjects are shown passages to read and are asked to state the main idea of the passages as single, brief, complete sentences. These response were analyzed both with a simple classifcation system, and with a detailed propositional system. In addition, reading times for the passages were collected, along with rankings of the importance of passage sentences. A sample of passages was used that varied widely in the amount of prior knowledge people have about the content. Two kinds of passages were used: One was based on the GENERALIZATION rule. These consisted of a series of specific examples of a generalization main idea, which either appeared explicitly in the first sentence (the good version), or was absent (the bad version). The other type of passage was based on the CONSTRUCTION rule. Here the main idea was an inference or conclusion that was followed by a series of facts supporting it. In the good version, the main idea again appeared in the first sentence; in the bad version the main idea was not explicitly stated. One group of subjects simply read each passage, with the reading time recorded, and then produced a statement of the main idea. A second group provided importance ratings of the passage sentences before stating their main ideas.

Method

Materials. Ten passages were prepared, each in a good and a bad version. Three passages, the Generalization passages, had the form of a general statement followed by several specific examples of the generalization, with several less relevant sentences included. These passages are shown in Tables 1, 4, and 7 below, and will be refered to as the metals, timekeeping, and instruments passages. The good version included a statement of the intended generalization as the first sentence. In the bad version, the general statement was removed and replaced by another specific sentence to produce a similar overall passage length. The specific form of the bad version varied somewhat between the passages.

Three other passages represented a Uniqueness manipulation. In the good version, the passage began with a statement of the main idea, and the passage was intended to be based on this single unique main idea. In the bad versions, the last sentence or sentences stated a second, related, but conflicting main idea. No noteworthy effects were observed with these passages, and so they will not be described or discussed further.

Finally, four passages, transportation, Watergate, Jutland, (shown in Tables 10, 13, and 16) and chess, were composed that should rely on the CONSTRUCTION rule. In the good versions, the construction passages began with a sentence stating the intended main idea in a direct, explicit fashion. This main idea was one that could be inferred from the passage, given adequate knowledge of the subject matter. In the bad versions, this sentence was replaced with a sentence that was a satisfactory initial sentence, but did not state the intended main idea. As above, there was some variation in how this was achieved in the four passages. As described below, the chess passage turned out to be defective, and will not be further described. The other construction passages are shown in the Tables below.

The passages were justified to occupy 80-character lines. They ranged from 9 to 12 lines in length, with the two versions of each passage very close to the same length. A numbered form of the passages was then prepared by inserting the sentence numbers with an arrow-like symbol in front of the first word of the sentence. The passages were then rejustified so that the numbers were embedded in a passage of normal appearance.

Design and Subjects. Two groups of 32 subjects were used, one for the normal main idea task, the other for the importance rating and main idea task. Within each group, each subject read and responded to one version of each passage, five of them being good versions, and five of them bad versions. The assignment of good and bad versions was made at random for consecutive pairs of subjects, with the members of each pair viewing complementary versions of the passages. Hence, for an even number of subjects, each passage would appear equally often in the two versions. Order of appearance of the passages was separately randomized for each subject.

The subjects were a total of 69 students of either sex at the University of Arizona recruited through advertisements and paid $2.00 for participating. Five of the subjects were dropped due to failure to produce complete sentences for responses, resulting in the final 64 subjects.

Instructions. The instructions were very similar to those used in Kieras(in press (a), in press (b)). Subjects were required to compose a statement of the main idea of each passage which met the following rules: The response had to be a single sentence that would fit on a single line of the computer terminal (80 characters). It had to be a complete sentence, not a word or phrase. It should not be a humorous or cute response. This last instruction was the major change from the earlier work just cited; previously subjects were required to produce something that was "actually mentioned" in the passage. Since subjects had rarely produced verbatim excerpts from the passage, the conclusion was that this instruction actually had the effect of discouraging flippant or overly "creative" responses. These instructions thus asked that subjects avoid such responses. For the rating task, subjects were simply instructed to list the numbers of the important sentences, the most important first, and continuing for as many as desired.

Apparatus and Procedure. The experiment was run with a Data General MicroNOVA lab computer which allowed running three subjects at once (Kieras, 1979). Each subject sat at a Teleray Model 3811 upper/lower case video terminal with an 80 character by 24 line screen, and driven at 9600 Baud. The computer performed the materials randomization and recorded reading times, sentence importance ratings, and main idea responses. Since reading times for whole passages were measured, an accuracy of only 1 second for the reading times was used.

Subjects were first instructed on how to type in their responses on the terminal keyboard and allowed to practice. Subjects who were not comfortable with typing were allowed to respond by writing on a notepad. Then they read the experimental instructions and began the experiment. To view each passage, the subject first tapped the space bar. Subjects in the normal main idea task tapped the space bar again when they finished reading the passage, whereupon the passage disappeared and was replaced with a prompt for entering their main idea response. Subjects in the rating task typed in their list of sentence numbers while the passage, with the sentence numbers, was still on the screen. When they finished typing, the passage was erased, and they entered their main idea sentence. The time the passage was left on the screen was recorded as the reading time, but is not reported for the sentence rating task group. The time required to type in the main idea was recorded as well but did not vary with any manipulations and so will not be reported.

Results

Analysis Methods

The basic approach in the analysis was to treat each passage individually, and the passage-by-passage description of the results is presented below.

The reading times for the group performing only the main idea task were averaged over subjects; these means will be presented for each passage. The sentence importance rating were treated as follows: The first mentioned, or most important, sentence in the list was given a rating of 1, the second mentioned a rating of 2, and so forth. Any sentences that the subject did not mention were given a rating equal to the number of sentences in the passage plus one. The mean ratings thus obtained are shown for each sentence in each passage in the Tables below, with the tables arranged so that the different sequences of sentences in the two versions can be distinguished.

The passages to be described all produced ratings in the good version giving more importance to the intended main idea sentence than to any other passage sentence. However, the chess passage failed to have this property; apparently the main idea was spread out over the first three sentence in the good version, and was concentrated in the third sentence. Thus the manipulation of whether the main idea was present or not misfired

for this passage. Although the passage produced overall results comparable with the other passages, it will not be described any further since the intended manipulation did not work.

The main idea responses were analyzed in two ways. The first method was to simply form about ten or fewer categories for the responses that captured the major kinds of responses, and included the intended main idea content in at least one of the categories. The was done blind with regard to the version of the passage associated with the response. The responses were then tabulated to show the frequency of responses in each category for each version of the passage. These frequency distributions are shown in the Tables below for each passage. The statistical questions concern whether the distributions for the two versions are different, and whether the distributions have a similar degree of dispersion, which indicates the consistency of responses for the versions. Differences in the distributions was tested with the usual chi-square test, but the small frequencies in some of the categories distorts this test, in that such cells contribute to the degrees of freedom, but will contribute little to the size of the test statistic. Rather than aggregate categories, which in this case would be rather arbitrary and confusing, a liberal significance level of .1 will be used. In the test for consistency, a procedure had to be invented since there are no standard procedures for testing dispersion in nominal data. This procedure consisted of first making the two distributions similar in shape by reordering the cells for each version so that each distribution is ordered from largest frequency to smallest. Thus if the two reordered distributions are different it must be due to a difference in how spread out or dispersed they are. This was tested by applying an ordinary chi-square test for identical distributions to the reordered distributions. Since the true distribution of the test statistic is unknown, this procedure should be considered suggestive rather than definitive. For the same reasons as above, a significance level of .1 was used. The categorization method for analyzing the responses has the advantage of being simple, and capturing the sometimes vague similarities between responses, but it is not as rigorous and detailed as the second method, which is based on the propositional content of the responses.

The first step in the propositional analysis method was to extract the propositions expressed in each response. This propositionalization was done along lines similar to Kintsch (1974) and Turner and Greene (Note 1). Then for each passage the different predicates, arguments, and propositions were determined by means of a program written in the LISP language that tabulated the individual terms and propositions. Due to the great variation in specific wording, an additional step in the analysis was required in which sets of synonymous predicates or arguments were replaced with single terms. Synonymous terms were combined by replacing the different terms with a single, synthesized, term, which was made distinct from the original terms. Then a second listing was done, and any additional synonymous terms combined, and any synonymous propositions or combinations of propositions were replaced with synthesized propositions. This reduced set of propositionalized responses was then ready for the

actual analysis.

Due to the many subjective judgments required in this process, care was taken to minimize any bias effects that might influence the conclusions. All of the above described steps were done blind with regard to the passage version associated with the response. Only after these steps were complete were the responses separated by good and bad passage versions. Furthermore, all of the initial propositionalization of the responses was done independently by two judges who then resolved any differences. The synonym replacement process was handled similarly for the three generalization passages and the transportation and Jutland passages. A single judge performed the synonym replacement for the remaining passages. Finally, the criterion for combining synonymous terms was fairly conservative; hence in some sense the analysis shows less similarity in the responses than is probably really there.

The analysis of the propositionalized responses consisted of examining the distribution of propositions produced for each version of each passage. As a measure of the typical sets of propositions, a LISP program was used to identify clusters of propositions. A cluster is a set of propositions such that for more than one response, each of the propositions appears in each of the responses, and are connected either by shared arguments or by embedding. The frequency of appearance of the various clusters gives a characterization of the "central tendency" in the content of the responses. The program used the following algorithm for finding clusters: First, all single propositions occurring in more than one response were collected. Then for each of these base propositions, all of the responses were examined, and the related propositions, those connected with the base proposition, were collected. Then each possible subset of these related propositions was formed, and the responses scanned for the combination of the base proposition and the subset of related propositions. The frequency of appearance of each such combination was then tabulated. Examining the tabulation allows one to assess the typical response content. However, since the propositional method, as currently practiced, tends to preserve some of the specific surface form of the response, such as the embedding relations between the propositions, the results from this analysis tend to reflect not just similarities in response content, but also in response structure and wording.

Preliminary examination of the propositionalized response tabulations showed no systematic differences between the normal main idea task and the sentence rating task. Hence the response results to be reported are based on the full 64 subjects, 32 for each passage version.

Generalization Passage Results

Metals. The metals passage is shown in Table 1, which shows each sentence for the two versions and the mean importance rating for each sentence. Where a sentence did not appear in one of the versions, there is no importance rating shown under that version. This passage was intended to be familiar in much of its content. The good version contained an initial generalization sentence, and the bad version was obtained by replacing the initial generalization with a specific sentence. Notice that the bad version thus has several early sentences that appear to group about an ancient history idea.

The mean reading times were 50.9 secs for the good version and 57.4 secs for the bad version, but these were not significantly different ($t(30)=.923$, $p>.1$). This suggests that readers found the bad version to be no more difficult than the good.

The intended main idea sentence received the unanimous first choice as most important, and as shown in the Table, was significantly more important than the first sentence in the bad version. Notice that the third, fifth, and last sentences were judged of low importance, which corresponds roughly to the apparent closeness to the intended main idea.

The response category distributions in Table 2 for the two versions were significantly different ($X^2(6)=10.900$, $p<.1$). Inspecting the table shows that the good version produced responses that essentially echoed the intended main idea, whereas the bad version produced a different main idea, but one of equal apparent quality. Furthermore, the distribution of responses appears to be equally consistent in the two versions. This was shown by the X^2 test on the ordered response categories ($X^2(5)=1.3$, $p>.9$). Thus readers of the bad version produced equally consistent, but different, responses compared to the good version readers.

The results of the propositional analysis of the responses are shown in Table 3. There was no important difference in the total number of propositions produced for the two versions of this passage, or for any of the passages. However, there is a suggestion that for this passage there are more different propositions in the bad version responses, and more singleton propositions. These are propositions which appear once, in only one response. However, the difference was not significant, suggesting that readers were just as consistent in the bad version as the good. Further evidence for this conclusion is that the number of subjects in the clusters were essentially identical for the two versions.

The cluster groups in Table 3 are English representations of the propositions making up the clusters, grouped together by apparent content for simpler presentation. The phrases separated by semicolons are separate clusters. Some clusters differed only slightly; these are combined together, with the alternate forms indicated by the bracketed phrases.

Table 1
Passage sentences and Mean Importance Ratings
for the Metals Passage

Version		
Good	Bad	Sentence
1.0*	---	Different metals have been used to satisfy the needs of various cultures.
---	2.8	Silver was used until quite recently in the United States as currency.
2.6	3.7	Bronze was used to make weapons that could cut through copper shields by the Hellenic tribes that invaded Greece long before the Trojan War.
7.7	7.5	The original inhabitants of Greece were easily overwhelmed by the land-hungry invaders because of their poorer weapons.
3.7	4.1	Gold was valued by the Incas for use in their religious ceremonies mainly because of its color.
8.4	6.6*	However, the Spanish conquest of the Inca Empire was undertaken because the Spanish valued gold for quite different reasons.
4.7	5.3	Aluminum, which is light in weight and does not rust or tarnish, became popular in the Western countries for camping and backpacking equipment.
5.3	5.1	Titanium is essential for modern industrial nations in the manufacture of jet airplanes and spacecraft.
8.8	8.3	It is probably most familiar in the brilliant "Titanium White" used in oil paints for artists.

* Difference between mean ratings is significant at .05 with a 2-tailed t-test. The first good version sentence was compared to the first bad version sentence.

Table 2
Response Categories and Frequency Distributions
for the Metals Passage

Version		
Good	Bad	Category
15	5	cultures used metals for various reasons
9	15	metals were used throughout history for different reasons
2	6	the uses, or importance, of metals
2	3	specific uses, or specific metals
3	2	miscellaneous about cultures and metals
1	0	different metals and different places
0	1	junk response

Table 3
Propositional Analysis for the Metals Passage

Version		
Good	Bad	
160	168	Total Number of Propositions
73	84	Different Propositions
49	61	Different Singletons
26	22	Subjects In Clusters

Number of Subjects Producing Each Cluster

Version		
Good	Bad	Cluster Description
6	2	different cultures use [different] metals [for different purposes]; different metals meet the needs of different cultures; uses of different metals in different cultures
4	16	[different] metals are used [in different ways, throughout history, for [different] reasons, worldwide, for a use]; metals are used and valued; different metals are valued for different reasons; mankind used metals throughout history
8	7	[many] [different] uses [and values] of [precious] metals [throughout history]; [different] metals are important [for different reasons]; uses of metals change
6	0	in different cultures; needs of different cultures; to different cultures
5	2	for [many] different reasons; in different places

The first group of clusters shown is very similar to the generalization sentence, being about how cultures used metals. Most of the subjects producing such responses were ones reading the good version, but the difference was not significant ($X^2(1)=2.286, p<.1$). In addition, more good version subjects used the propositions about cultures shown in the fourth cluster group ($X^2(1)=6.621, p<.02$). More bad version subjects than good version subjects produced responses in the second group about metals being used for various purposes or throughout history ($X^2(1)=10.473, p<.01$). This group appears to contain clusters whose quality as main ideas is as high as the first group. Equal numbers of subjects mentioned the uses or importance of metals, or miscellaneous differences.

Thus in summary, the metals passage was familiar and clear enough to readers that they were able to abstract its main idea fairly successfully regardless of whether or not the main idea was explicitly stated. The main idea implied by the bad version was somewhat different from the one stated in good version, but the ease of abstracting the implicit main idea, and the consistency of it across subjects, matched that when the main idea was explicit.

Timekeeping. The timekeeping passage shown in Table 4 is similiar in construction to metals, and is less familiar than metals in content, but still deals with some familiar objects.

The mean reading time for the good version was similar to that of metals, 52.1 secs, but the bad version time was much longer, at 81.3 secs ($t(30)=2.437, p<.05$). Apparently the bad version was much harder to work with than the good.

As in metals, the intended main idea sentence, the first sentence of the good version, was the unanimous first choice for the most important sentence. Notice that the third and fifth sentences are judged of low importance, again because they are relatively unrelated to the main idea. Notice that the last sentence is judged more important in the bad version than in the good; apparently there is some tendency to view this sentence as a concluding statement of some sort, as if the passage was presenting the development that led up to the hydrogen maser clock. A similar development-climax pattern appears in other passages to be described.

The response category distributions shown in Table 5 for the two versions were very different ($X^2(7)=24.189, p<.01$). Moreover, the ordered frequency distributions were also rather different ($X^2(7)=14.076, p<.05$), showing that the bad version responses were less consistent than the good. From the Table, it is clear that most good version readers echoed the intended main idea, but bad version readers produced a variety of responses, tending to group around the notion that timepieces vary in accuracy. Some bad version readers, however, did produce the intended main idea.

Table 4
Passage sentences and Mean Importance Ratings
for the Timekeeping Passage

Version		
Good	Bad	Sentence
1.0*	---	Modern timekeeping devices are extremely accurate.
---	3.4	An ordinary digital alarm clock will be correct within a second per day.
4.9	3.6	An inexpensive quartz-crystal watch, now being sold for less than ten dollars, will stay accurate to a few seconds per week.
6.4	5.7	Greater accuracy can be achieved with proper adjustment.
4.2	3.9	An atomic resonance clock is precise to a millionth of a second over several years.
6.0	5.8	A portable one was used to measure the tiny time distortions predicted by Einstein's theory that would be produced by taking an around-the-world trip by commercial airliner.
4.4	2.5*	The hydrogen maser master clocks now used by the National Bureau of Standards are sophisticated precision instruments that gain or lose less than one second over 10 million years.

* Difference between mean ratings is significant at .05 with a 2-tailed *t*-test. The first good version sentence was compared to the first bad version sentence.

Table 5
Response Categories and Frequency Distributions
for the Timekeeping Passage

Version		
Good	Bad	Category
24	7	modern timekeeping devices are accurate
2	2	timekeeping devices are accurate
0	10	different clocks have different accuracies
2	2	specific device, or specific accuracy
0	4	the more complex the clock, the more accurate
1	2	specific ways to make a clock more accurate
2	3	technology has produced better clocks
1	2	miscellaneous

The propositional analysis, shown in Table 6, agrees with the above results to some extent. The apparent difference between versions in the number of different propositions and the number of singletons is not significant (*p*s>.2), and likewise there is no difference to be seen in the cluster analysis. However, the qualitative difference in the cluster content corresponds closely to the reponse categories already described. In the *timekeeping* passage, there were two major groups of structures, both about the idea that timekeeping devices are accurate, but the first group includes a modifier that *today's* devices are accurate. Thus readers of both versions used similar propositions, but more good version readers than bad version picked up the *modern* modification of timekeeping devices ($X^2(1)=18.618$, $p<.001$). More bad version readers than good used the idea of accurate timekeeping devices without the *modern* modification ($X^2(1)=3.473$, $.1>p>.05$). Another feature is that only bad version readers used propositions stating a comparison between timekeeping devices ($X^2(1)=10.473$, $p<.01$).

Thus the *timekeeping* passage differs from *metals* in that the good version produces highly consistent responses that echo the intended main idea in a small amount of reading time, but the bad version produces a great variety of responses, and takes considerably longer to read. This difference can be attributed to the lower familiarity of the technical concepts in the passage, compared to *metals*, rather than to any other differences such as the logical structure of the passage, since *timekeeping* seems simpler in structure than *metals*. However, readers could have tried to construct a main idea around the apparent sequence-climax structure of the bad version, failed to do so satisfactorily, and settled for haphazardly chosen other ideas.

Instruments. This passage, shown in Table 7, is rather unfamiliar in subject matter, and the intended main idea sentence is also rather complex. The bad version was obtained by deleting the intended generalization sentence and inserting a new third sentence.

The reading time for the good version was longer than that for *metals* and *timekeeping*, being 65.6 seconds, and very long for the bad version, 89.9 seconds ($t(30)=2.579$, $p<.05$). Hence the good version was more difficult than the more familiar passages, but the bad version was as difficult as the bad version of *timekeeping*.

Despite the unfamiliarity and difficulty of this passage, the intended main idea sentence was still the unanimous first choice for the most importance sentence. Notice however, that in the good version, all of the other sentences are of roughly equal importance, which is reasonable given the intended main idea. Thus the difficulty of the good version compared to the other passages could be due in part to there simply being more information to be considered. In the bad version, notice that the third sentence, the added filler, is dismissed as irrelevant, and the last sentence is the most important. This suggests that readers viewed the bad version as having a sequence-climax structure.

Table 6

Propositional Analysis for the Timekeeping Passage

Version		
Good	Bad	
174	176	Total Number of Propositions
65	83	Different Propositions
44	51	Different Singletons
27	26	Subjects In Clusters

Number of Subjects Producing Each Cluster

Version		
Good	Bad	Cluster Description
18	2	very accurate modern timekeeping devices; [many] timekeeping devices are [very] accurate today; modern timekeeping devices achieve accuracy; accurate timekeeping devices exist today; modern timekeeping devices achieve much accuracy; modern clocks and watches are very accurate; today timekeeping devices exist that have accuracy that is ultraprecise over millions of years
7	14	[very] accurate timekeeping devices; very accurate clocks; timekeeping devices achieve [more] accuracy; accuracy of timekeeping devices; man devised [very] accurate timekeeping devices; time is kept accurately; devices range in accuracy from precise to ultraprecise; very accurate timekeeping devices are available
4	2	modern timekeeping devices; man's timekeeping devices; more sophisticated timekeeping devices
0	9	some [timekeeping] devices are more accurate than other [timekeeping devices]; different timekeeping devices vary in their accuracy; different timekeeping devices have different degrees of accuracy
2	1	over millions of years

Table 7
Passage sentences and Mean Importance Ratings
for the Instruments Passage

Version		
Good	Bad	Sentence
1.0*	---	The mechanics of keyboard instruments differ in what they allow the performer to control.
4.9	3.7	In the oldest keyboard instrument, the clavichord, a small metal hammer at the end of the key strikes the string which then vibrates between the hammer and the bridge.
5.3	4.6	Since the key is in direct contact with the string, the player is able to control its pitch.
---	7.1	This feature, together with its clear sound, made the clavichord a favorite for many years.
5.8	5.3	In the harpsichord, pressing the key causes a small stiff finger, the plectrum, to pluck the string.
5.1	5.9	Since the plectrum always moves the same distance, the performer can not control the loudness of the tone produced.
6.7	6.2	Finally, in the piano, the mechanism throws the hammer against the string.
6.7	5.5	The force with which the hammer strikes depends on how hard the key is struck.
6.2	3.4*	This enables the piano performer to control the loudness of the music for each individual note, thereby achieving a degree of expressiveness not possible on the earlier instruments.

* Difference between mean ratings is significant at .05 with a 2-tailed t-test. The first good version sentence was compared to the first bad version sentence.

The response categories shown in Table 8 were different for the two versions ($X^2(9)=21.377$, $p<.01$), and the bad version distribution appears somewhat more consistent than the good, but is not significantly so according to the ordered frequency test ($X^2(8)=4.861$, $p>.70$). The most remarkable feature of the responses is how few captured the intended main idea; only seven good version readers came close, with eleven others picking up fragments based on the notion of differences. Perhaps the apparent poor quality of the responses is due to the complexity of the intended main idea; the subjects simply may have had trouble phrasing their response to fit into the length restrictions. On the other hand, many of the bad version readers organized the passage around a specific instrument, the piano, and appeared to organize the passsage around a sequence-climax form of the development of the piano. Given the familiarity of the piano relative to the other instruments, and the unfamiliarity of keyboard instruments as a concept, the superiority of the piano could have been the only general idea available to the subjects. Notice how many of the bad version readers failed to generalize, but instead focussed on specific instruments or their properties.

The propositional analysis shown in Table 9 highlights the problems with instruments dramatically. Although the total number of propositions is comparable to timekeeping, the number of different propositions is much greater. The number of singleton propositions is also much greater, both in comparison to metals ($X^2(1)=50.533$, $p<.001$), and timekeeping ($X^2(1)=80.162$, $p<.001$). The number of clusters in instruments is also considerably fewer than in the others. Although such comparisons are contaminated by possible differences in the propositional analysis process itself, it is a strong suggestion that the instruments passage produced response that were much less consistent on the whole than in the more familiar passages.

The different versions produced differences in the propositional content of the responses. As shown in Table 9, the number of singletons was greater in the bad version than in the good ($X^2(1)=5.750$, $p<.05$). The number of subjects participating in the clusters was grossly fewer in the bad version ($X^2(1)=14.769$, $p<.001$). Since there are so few clusters, their content does not characterize the typical response very well. However, notice that more good version readers produced responses using the idea of the mechanism of keyboard instruments ($X^2(1)=4.267$, $p<.05$), or of differences in keyboard instruments ($X^2(1)=16.314$, $p<.001$). Notably, one of the two clusters produced in the bad version was rather specific, about the piano.

Thus, the instruments passage, being rather unfamiliar and complex, suffered disastrous effects in the bad version. The passage took a long time to read, the consistency of the responses was poor overall, and most subjects failed to get the point, even when it was explicitly stated. But the propositional analysis shows that the presence of the main idea sentence helps guide some of the content of the responses, so that more good version readers shared a core of propositions than bad version readers. In spite of the problems readers had with the passage,

Table 8
Response Categories and Frequency Distributions
for the Instruments Passage

Version		
Good	Bad	Category
7	4	difference in mechanisms means a difference in sound or what the performer can control
5	0	difference in control
3	0	difference in mechanisms
3	0	difference in instruments
5	12	the piano is superior to, or culmination of, the other keyboard instruments
0	6	specific instruments and differences
2	2	specific qualities or means of control
1	2	mechanisms of keyboard instruments
2	3	musical instruments in general
4	3	instruments have evolved

Table 9
Propositional Analysis for the Instruments Passage

Version		
Good	Bad	
166	164	Total Number of Propositions
110	129	Different Propositions
91	111	Different Singletons
20	5	Subjects In Clusters

Number of Subjects Producing Each Cluster

Version		
Good	Bad	Cluster Description
8	2	mechanisms of [different] keyboard instruments
13	0	different keyboard instruments; keyboard instruments differ in something; earlier keyboard instruments; modern and old keyboard instruments
2	0	the performer controls keyboard instruments;
0	3	the piano is a keyboard instrument

they could still single out as most important the explicit main idea in the good version, and dismiss an irrelevant detail even in the bad version.

Construction Passage Results

Transportation. The transportation passage, shown in Table 10, resembles a generalization passage, but the logical relation between the intended main idea and the passage is not that of generalization, but rather that of of an assertion supported by specific facts. The bad version of this passage was prepared by deleting the initial statement of the intended main idea and adding another sentence to the end.

The reading time for the good and bad version did not differ significantly, being 53.9 secs and 55.4 secs respectively. Note that this is as fast as the metals passage. Unlike the generalization passages, and like the other construction passages, the initial main idea sentence in the good version was not the unanimous first choice for the most important sentence. This pattern suggests that these passages are rather different in their macrostructural properties than the generalization passages. Notice that in the bad version, the second sentence, about cars being accessible and convenient, is the most important sentence.

The response category distributions, shown in Table 11, are marginally different ($X^2(10)=14.663$, $.2>p>.1$), and similarly consistent ($X^2(9)=1.577$, $p>.99$). The most popular response in both versions corresponds closely to the intended main idea. In the good version, there was some tendency for more subjects to use the idea of popularity from the intended main idea than in the bad version, where more subjects picked up the convenience notion from the most important sentence in that version.

The quantitative measures from the propositional analysis, shown in Table 12, show no difference between versions in the consistency of the responses; overall the numbers are comparable to those of the familiar metals passage. The content of the important clusters corresponds closely with the response category results. Equal number of subjects in both versions used the idea that cars were popular.

Thus, like the familiar metals passage, the transportation passage produced responses in both version that were either identical or equal in quality, with no difference in the time required. Unlike the generalization passages, however, the relative importance of the explicit main idea sentence was not as pronounced.

Watergate. The Watergate passage, shown in Table 13, deals with subject matter that is very familiar in general terms, but contains many specific facts, all of which, incidentally, are based strictly on the public record. The good version contains an initial statement of the main idea that Nixon resigned because of Watergate. The last sentence repeats that Nixon resigned, but

Table 10
Passage sentences and Mean Importance Ratings
for the Transportation Passage

Version		
Good	Bad	Sentence
2.3	---	The car is by far the most popular form of transportation in the United States today.
3.8	3.2	Cars are a less economical form of transportation than the bus but people prefer to use their cars most of the time because they find buses inconvenient and slow.
5.0	2.6*	Cars are accessible and convenient whether only for a trip to the store or across country.
5.1	4.8	Although trains were once very popular, today most train services operate at a loss, while there are more cars on the road than ever.
7.3	6.7	Railbeds and rolling stock fall into disrepair through money shortages but new highways are built every month, at a cost of millions of dollars.
6.3	5.8	Though the speed of aircraft makes them attractive and glamorous, they are a very expensive way to travel.
5.8	6.5	This means that most people use them only occasionally for long distance travel preferring their cars for more routine, shorter trips.
---	5.4	The rise of gasoline prices has made the bicycle more popular, though it still is not a major form of transportation.

* Difference between mean ratings is significant at .05 with a 2-tailed *t*-test. The first good version sentence was compared to the first bad version sentence.

Table 11
Response Categories and Frequency Distributions
for the Transportation Passage

Version		
Good	Bad	Category
12	11	the car is the most popular or most preferred
5	0	the car is more popular than a specific other means
4	0	the car is more popular for a specific use
2	5	the car is popular because it is convenient
1	1	the car is popular because it is convenient, but it is not economical
3	3	the car is popular, but not economical
0	2	the car is convenient
1	2	the car is convenient, but not economical
1	4	other advantages of cars
2	3	general remarks about transportation
1	1	general remarks about cars

Table 12
Propositional Analysis for the Transportation Passage

Version		
Good	Bad	
176	172	Total Number of Propositions
81	82	Different Propositions
54	59	Different Singletons
24	21	Subjects In Clusters

Number of Subjects Producing Each Cluster

Version		
Good	Bad	Cluster Description
10	10	the car is the [most] popular form of transportation [in the U.S. [today]]; the car is most popular
3	5	the car is more convenient; the car is the convenient form of transportation; because the car is convenient people use cars; people use convenient cars
5	6	the car is [still] the form of transportation [in the U.S.]; although the car is economical; people prefer the car to other forms of transportation
7	2	economical form of transportation; over other forms; cars buses trains and airplanes are used; other forms of transportation

Table 13
Passage sentences and Mean Importance Ratings
for the Watergate Passage

Version		
Good	Bad	Sentence
3.1	---	The affair known as Watergate caused Nixon to resign from the presidency.
5.5	3.0*	On June 17, 1972, five men were arrested for illegally entering the offices of the Democratic National Committee at the Watergate building in Washington D. C.
---	6.3	One of them was James McCord, who was head of security for the Committee to Re-elect the President.
4.9	4.4	In subsequent investigations by the House, Senate, and the Special Prosecutor, more than 30 Nixon administration officials, campaign officials, and financial contributors were found guilty of breaking the law.
4.1	3.6	Tapes of White House conversations implicated Nixon himself.
5.9	7.2*	A House committee voted in favor of several articles of impeachment.
3.3	5.2*	The charges against him were that he obstructed justice in the Watergate break-in, that he had not obeyed House subpoenas, and that he had misused his authority in activities such as wiretapping.
5.1	3.6	On August 9, 1974, Nixon resigned from the presidency.

* Difference between mean ratings is significant at .05 with a 2-tailed t-test. The first good version sentence was compared to the first bad version sentence.

nowhere else in the passage is the causal connection between Watergate and the resignation explicitly stated. The bad version was prepared by deleting the first sentence and inserting a detail sentence as the second sentence. The sentence that appeared first in the bad version was chosen so that it could stand as an initial sentence.

The reading time for the bad version, 57.2 secs, was somewhat longer than the time for the good version, 47.1 secs, and the difference was marginally significant ($t(30)=1.376$, 1-tail $p<.1$).

Notice that the intended main idea sentence in the good version is only slightly more important than the next-to-the-last sentence which states the charges against Nixon. Hence in this passage as well, the explicit statement of the main idea does not have the prominence it has in the generalization passages. Further differences in the important ratings appeared. The first and sixth sentences are significantly more important in the good than in the bad version, but the last sentence goes the opposite way. Apparently, the intended main idea sentences directed the reader's attention to the impeachment activities again Nixon, but rendered the last sentence redundant. But in the bad version, the passage appears to be leading up to the conclusion of Nixon's resignation. The chain of events involved would make the first and the last sentences stand out.

Despite the clear differences in processing the two versions that are implied by the reading times and the importance ratings, the response categories, shown in Table 14, are remarkably similar, differing neither in distribution ($X^2(5)=.926$, $p>.98$) nor in consistency ($X^2(5)=.926$, $p>.98$). In both versions, the most popular response category was essentially the intended main idea. Perhaps due to the controversial or notorious nature of the passage content, a small but noticeable number of readers stated that Nixon broke the law, which was not stated by the passage, or produced "editorials" about the corruption of politicians.

The propositional analysis shown in Table 15 yielded a large number of singletons compared to transportation, and few clusters, or subjects participating in them. Although the number of singletons produced by the two versions is the same, there are actually more subjects participating in clusters in the bad version than in the good.

The content of the clusters clarifies this counter-intuitive result. Identical numbers of subjects used the intended main idea. A few more bad version readers than good used an idea about Nixon resigning after something, or that various events led to the resignation. Finally, a few more subjects produced miscellaneous fragments that happened to appear in more than one response. Hence the clusters that actually contain substantive propositions show little or no difference between versions.

Table 14
Response Categories and Frequency Distributions
for the Watergate Passage

Version		
Good	Bad	Category
13	12	Nixon resigned because of Watergate
6	4	Nixon resigned because of other illegal events
6	8	Nixon or his administration broke the law or was guilty
2	2	Nixon resigned
2	3	Editorial remarks
3	3	Miscellaneous

Table 15
Propositional Analysis for the Watergate Passage

Version		
Good	Bad	
129	138	Total Number of Propositions
89	91	Different Propositions
72	76	Different Singletons
9	14	Subjects In Clusters

Number of Subjects Producing Each Cluster

Version		
Good	Bad	Cluster Description
5	5	[President] Nixon resigned from the presidency because of Watergate [affair]; the Watergate [affair, breakin] lead to [President] Nixon resigning from the presidency.
2	5	[implications, events] lead to [President] Nixon resigning from the presidency; after something [President] Nixon resigned from the presidency
2	1	in the Watergate affair; because of the Watergate affair
0	2	President Nixon broke the law
0	2	many of Nixon's officials

Thus, the watergate passage, with its familar topic but unfamiliar details, showed version effects on what the readers considered and how long they took to read, but no version effects on what was contained in the responses. Although it was read quickly, there were substantial inconsistencies in the specific content of the responses; few subjects participated in the clusters.

Jutland. The Jutland passage, shown in Table 16, is comparable to instruments in that it is about rather unfamiliar subject matter and contains several unfamiliar technical terms. The bad version was prepared by replacing the intended main idea sentence with one that performed the same function of introducing the name of the battle and the two forces involved, but did not say anything about the outcome. The second sentence was then lengthened somewhat to yield the same passage length as the good version. Notice that to the naval history novice, the passage may be puzzling, especially in the bad version, because the outcome of the battle is not at all clear; it is not obvious who came out on top and why.

The reading time for the good version was 90.1 secs, for the bad version, 88.6 secs. The difference is in the wrong direction, but fails to approach significance ($t(30)=.108$). This large reading time, comparable to that for the bad version of the unfamiliar instruments passage, means that readers had a difficult time with this passage. Notice that the passage is written in a relatively plain literary style, suggesting that the long reading time is a function of the content, not of difficult construction.

The initial intended main idea sentence was rated as highly important, but not unanimously so; subjects failed to give it the first rank. This prominence of the main idea sentence resembles the generalization passages more than the other construction passages. However, notice that the first sentence of the bad version also is very important, which argues that it is not the specific content of the intended main idea sentence which produces its high rating, but rather the structure of the passage as a whole. Perhaps this structure is in the form of an introduction followed by a sequence, rather than a conclusion-argument form. But it is a puzzle why the readers gave little importance to the last two sentence summarizing the outcome of the battle. Instead, they considered the fourth and fifth sentences important, perhaps because they contain the climax of the battle. Finally, notice that the second sentence is dismissed in the good version, where it is just a transition, but is considered fairly important in the bad version, where it initiates the narrative sequence anticipated by the first sentence.

The distribution of the response categories, shown in Table 17, were different ($X^2(8)=14.303$, $p<.1$), and the consistency was the same ($X^2(7)=.725$, $p>.98$). The most striking feature of the responses is how few subjects produced the idea that although the British won, there was a qualification to their victory. In the good version, only seven subjects in two categories did so, in

Table 16
Passage sentences and Mean Importance Ratings
for the Jutland Passage

Version		
Good	Bad	Sentence
1.2	---	In the World War I Battle of Jutland, although the British navy failed to destroy the German fleet, they won a major strategic victory.
---	1.9	The World War I Battle of Jutland was an encounter between the British Grand Fleet and the German High Seas Fleet.
5.9	---	The battle began when the battle cruiser scouting forces of the two fleets sighted each other and opened fire.
---	4.7	The battle began when the battle cruiser divisions, acting as scouting forces for the two fleets, sighted each other and opened fire.
6.6	6.0	The fleets grew closer together in the mists of the North Sea, until finally the main battleship groups encountered each other.
4.3	4.7	The British attained a greatly superior position, the decisive "crossing-the-T."
4.3	5.1	But the Germans had practiced evading superior forces, and so carried out a superb "battle turn away together" that was not even in the British maneuvers book, and so escaped the trap.
5.6	6.1	But in the meantime, the British lost three battle cruisers, and the Germans lost one obsolete battleship.
5.8	5.8	The German fleet never again left harbor except to surrender.

Note: None of the comparisons of ratings between corresponding sentences in the two versions were significant.

Table 17
Response Categories and Frequency Distributions
for the Jutland Passage

Version		
Good	Bad	Category
7	7	unqualified British victory
3	1	tactical failure, but strategic victory for British
4	0	qualified British victory
1	3	German failure
9	8	German success, qualified success, successful escape
1	4	battle involved British and Germans
2	7	neutral commentary about both forces in the battle
5	1	the battle was important
0	1	junk response

the bad version only one. Seven other subjects in each version stated that the battle was an unqualified British victory, but more subjects stated that it was a success for the Germans. The difference between the versions is largely due to differences between the relatively uninteresting categories that correspond to statements that were neutral about the outcome of the battle.

The propositional analysis, shown in Table 18, produced no differences in the number of different propositions or singletons between the two versions; however, this passage produced a considerable number of singletons, more than transportation ($X^2(1)=26.093, p<.01$). In the clusters, no readers of the bad version used the idea that the British won, while some good version readers did ($X^2(1)=7.860, p<.01$). This disagrees with the results for the the response categories described above. The discrepancy can be reconciled on the basis that the explicit main idea sentence in the good version induced some consistency in the form of the responses, so that some clusters appeared in the good version. But in the bad version, subjects stated their main idea in a variety of ways, without the guidance of an explicit main idea sentence. So, the few subjects who stated the idea of British victory did so in essentially unique ways, resulting in no clusters expressing this idea in the bad version.

DISCUSSION

Conclusions

Although each of the passages described has its own peculiarities, several conclusions emerge from the results.

The good versions had obvious main ideas in the generalization passages, but not in the construction passages. This suggests that the structure of generalization passages is very clear and simple compared to the construction passages, corresponding to the difference in complexity of the macrostructure-building rules. The explicit generalization main idea sentence is very recognizable, perhaps on the basis of superficial features, since it was easily spotted by the subjects even in the unfamiliar instruments passage. One candidate for such a superficial feature is the appearance of general rather than specific terms. The fact that the intended main idea was not as obvious in the construction passages is intriguing. Of course a possible explanation is that the construction passages were simply of inferior quality, so that in fact they were organized only poorly around the intended main idea. But the familiar transportation passage produced extremely consistent responses stating the intended main idea, but nonetheless, the explicit main idea sentence was rated as only fairly important, rather than unanimously most important as in the generalization passages. Hence, the basic conclusion-argument form underlying the construction passages must be in some sense less tight in its macrostructure than the generalization-example form. If for no other reason, the interconnected arguments supporting a conclusion may be viewed as tightly bound up with the conclusion,

Table 18
Propositional Analysis for the Jutland Passage

Version		
Good	Bad	
170	162	Total Number of Propositions
109	102	Different Propositions
91	81	Different Singletons
15	7	Subjects In Clusters

Number of Subjects Producing Each Cluster

Version		
Good	Bad	Cluster Description
7	0	the British Navy won a [strategic] victory [in the Battle of Jutland]; the British Navy defeated the German Fleet
3	0	a major strategic victory; the Battle of Jutland was the major victory
6	7	in the Battle of Jutland; the Battle of Jutland was a [major] naval battle [in WWI]; the Battle of Jutland was fought between the British Navy and the German Fleet
2	0	fragment: but not

but the fairly unrelated specific examples of a generalization are easily separable from the generalization itself.

Relevant and irrelevant sentences can be distinguished even in unfamiliar material. One would expect that readers could distinguish relevant information in familiar passages. However, an intuitive prediction of how instruments and Jutland would be handled was that readers would be completely befuddled and unable to make any sense out of the passage whatever. However, their importance ratings were well-behaved, and show that they can tell what is important, and organize the bad versions of the passage around other main ideas. To a great extent, the problem in these passages seems to be in formulating a statement of the main idea, rather than in identifying the important content.

Explicit main ideas are echoed in the responses. Given that readers can spot an explicit main idea, they have a strong tendency to model their responses on that sentence. This appears, for many of the passages, in the great similarity of the most popular response categories in the good versions to the intended main idea sentence. Another indication is the general tendency for more propositional clusters to appear in good version responses than in bad version responses. The guidance provided by the good version is weaker in the unfamiliar passages, but this could be due to the relatively complex intended main ideas in instruments and Jutland.

When a main idea is not explicit in a familiar passage, readers can produce one. It is clear from metals, transportation, and Watergate that readers can produce main ideas of high quality for passages that are reasonably familiar even if they are not explicitly stated. The timekeeping and instruments passages seem to revert to an alternate organization when the intended main idea is not explicit, but only some readers pick up the alternate structure. Hence, for unfamiliar passages, lack of an explicit main idea will result in inconsistent responses reflecting the different alternate organizations that the passage might have, and the idiosyncratic knowledge and strategies of individual readers.

Reading times do not always show version effects. For the generalization passages, the reading times make a nice pattern: The familiar metals passage produced neither reading time nor response content differences between versions. The unfamiliar timekeeping and instruments passages produced both reading time and response content differences. However, the only construction passage showing a time difference was Watergate, where the effect was weak, and the responses were not different. Transportation was very familiar and produced both very similar responses and reading times in the two versions, but Jutland was very unfamiliar, and produced responses that were similiar in their poor quality for the two versions, and reading times that were also similar in their great length. However, there is an obvious and very strong ordering of mean reading times across passages that corresponds well to their familiarity. Hence the inconsistent appearance of reading time effects could be explained as follows: In generalization passages, lack of an

explicit main idea results in longer reading time if an equivalent main idea is not easily inferred due to unfamiliar content. In the construction passages, the explict intended main idea sentence is not as important relative to the rest of the passage as is the case in the generalization passages. Hence whether or not it is present is relatively unimportant to the reading time; any effects are likely to be masked by the ease of inferring a main idea if the passage is familiar, or the overall difficulty of understanding the passage at all if it is unfamiliar.

A Model for Generating Main Ideas

An informal model that explains some of the main features of the results is shown in flowchart form in Figure 1. The reader first determines, on the basis of superficial features, whether the first sentence appears to state a main idea. If so, it is used as the candidate main idea for the passage. If not, the reader attempts to extract a main idea based on the first sentence, and use this as the candidate main idea. Then the reader determines whether the rest of the passage can be subsumed under the candidate main idea. If so, the reader outputs that main idea and stops. If not, the reader attempts to devise a main idea based on the whole passage content.

The various boxes in the model can be justified as follows: The special role given to the first sentence is consistent with (a) the previous work on initial mention effects cited above; (b) the importance ratings given to the first sentences; note how the first sentence of the bad versions was rated as more important than when the same sentence appears in the good version, and usually as more important than later sentences in the bad version; (c) the tendency of good version readers to echo the initial explicit main idea sentence. That this special role for the first sentence can take effect before the rest of the passage is considered seems to be justified by the apparent superficial differences between explicit main idea sentences and the other passage sentences, such as the use of general nouns rather than specific ones. That readers might base a main idea on a first sentence that is not an obvious main idea sentence is supported to some extent by the generally high importance ratings given the first sentence in the bad versions. However, it seems reasonable that in this experiment readers could often hypothesize a main idea from the first sentence, for example, by generalizing it. However, more direct evidence is needed on this point.

The decision about whether the rest of the passage is subsumed is obviously a very complex one; van Dijk's macro-rules are a possible basis for how this might be done. Given that van Dijk's GENERALIZATION rule is apparently much simpler in form and application than the CONSTRUCTION rule, it seems reasonable that the subsumption decision is easier and more consistent for a generalization passage than for a construction passage. Note that the model says that the reader tries a candidate main idea based on the first sentence, and then simply outputs it if it is

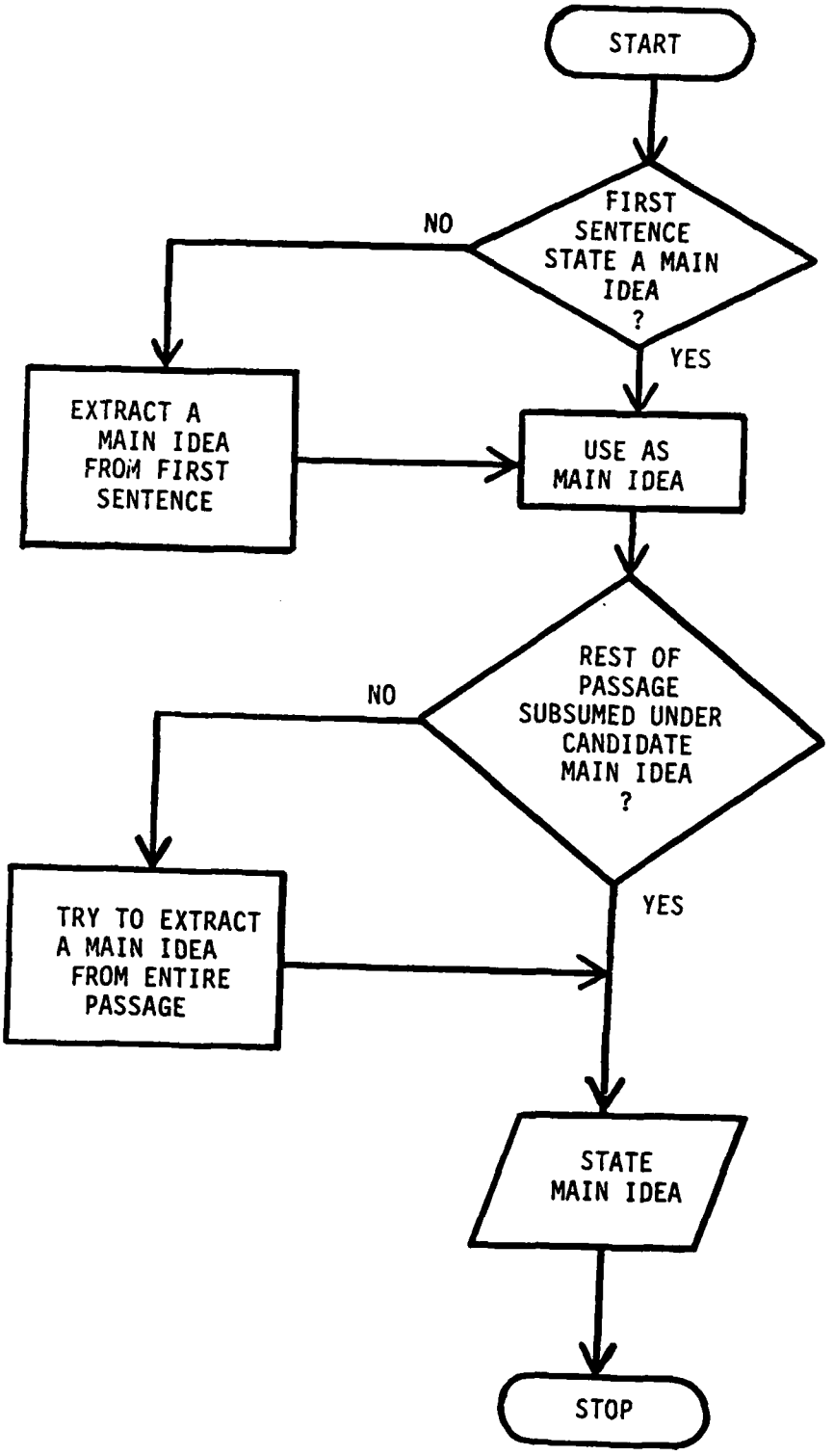

START
FIRST SENTENCE STATE A MAIN IDEA ?
NO
YES
EXTRACT A MAIN IDEA FROM FIRST SENTENCE
USE AS MAIN IDEA
REST OF PASSAGE SUBSUMED UNDER CANDIDATE MAIN IDEA ?
NO
YES
TRY TO EXTRACT A MAIN IDEA FROM ENTIRE PASSAGE
STATE MAIN IDEA
STOP

FIGURE 1.

adequate to subsume the rest of the passage. This is justified by the tendency to reproduce the explicit main idea; hence alternative macrostructures for the passage appear rarely in the good versions, because according to the model, the reader does not consider any candidate except the explicit main idea.

The process that tries to extract the main idea from the whole passage if the subsumption attempt fails is poorly defined at this point. Again, it should be based on the macro-rules, but there may be a schema-directed component as well. That is, a common alternative organization for the bad versions was the sequence-climax form. This, and other fine details of the results, suggests that readers apply a passage schema which helps organize the passage by suggesting which propositions are important to the macrostructure. In fact, the model assumes one such schema, the form of initial main idea followed by support. Hence the extraction box may consist of a series of attempts to apply flowcharts similar to Figure 1.

Prospects

These results show that it is possible to study the macrostructure building process fairly directly, although such work will be complicated and may have to consist of loose generalizations from the results of several individual passages, rather than statistical generalization from several passages supposedly identical in form. Further work will be to collect think-aloud protocols which should reveal much about the model, and development of the model in the explicit form of a set of production rules based on van Dijk's rules.

Reference Notes

1. Turner, A., & Greene, E. The construction and use of a propositional text base. Institute for the Study of Intellectual Behavior, Technical Report No. 63. University of Colorado, April, 1977.

References

Clements, P. The effects of staging on recall from prose. In R. O. Freedle (Ed.), New directions in discourse processing. Norwood, New Jersey: Ablex Publishing Corporation, 1979.

Kieras, D. E. Doing it the vendor's way: Running multiple subjects in reading experiments using Data General's Diskette Operating System. Behavior Research Methods and Instrumentation, 1979, 11, 221-224.

Kieras, D. E. Initial mention as a signal to thematic content in technical passages. Memory Cognition, in press.(a)

Kieras, D. E. The role of major referents and sentence topics in the construction of passage macrostructure. Discourse Processes, in press. (b)

Kintsch, W. The representation of meaning in memory. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1974.

Kintsch, W., & van Dijk, T. A. Toward a model of discourse comprehension and production. Psychological Review, 1978, 85, 363-394.

Schank, R. C., & Abelson, R. P. Scripts, plans, goals, and understanding: An inquiry into human knowledge structure. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977.

van Dijk, T. A. Text and context. London: Longman, 1977. (a)

van Dijk, T. A. Semantic macro-structures and knowledge frames in discourse comprehension. In M. Just & P. Carpenter (Eds), Cognitive processes in comprehension. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977. (b)

van Dijk, T. A. Relevance assignment in discourse comprehension. Discourse Processes, 1979, 2, 113-126.

Navy

1 Dr. Ed Aiken
Navy Personnel R&D Center
San Diego, CA 92152

1 Meryl S. Baker
NPRDC
Code P309
San Diego, CA 92152

1 Dr. Robert Breaux
Code N-711
NAVTRAEQUIPCEN
Orlando, FL 32813

1 Chief of Naval Education and Training
Liason Office
Air Force Human Resource Laboratory
Flying Training Division
WILLIAMS AFB, AZ 85224

1 Dr. Richard Elster
Department of Administrative Sciences
Naval Postgraduate School
Monterey, CA 93940

1 DR. PAT FEDERICO
NAVY PERSONNEL R&D CENTER
SAN DIEGO, CA 92152

1 Dr. John Ford
Navy Personnel R&D Center
San Diego, CA 92152

1 Dr. Henry M. Halff
Department of Psychology,C-009
University of California at San Diego
La Jolla, CA 92093

1 LT Steven D. Harris, MSC, USN
Code 6021
Naval Air Development Center
Warminster, Pennsylvania 18974

1 Dr. Patrick R. Harrison
Psychology Course Director
LEADERSHIP & LAW DEPT. (7b)
DIV. OF PROFESSIONAL DEVELOPMMENT
U.S. NAVAL ACADEMY
ANNAPOLIS, MD 21402

Navy

1 CDR Robert S. Kennedy
Head, Human Performance Sciences
Naval Aerospace Medical Research Lab
Box 29407
New Orleans, LA 70189

1 Dr. Norman J. Kerr
Chief of Naval Technical Training
Naval Air Station Memphis (75)
Millington, TN 38054

1 Dr. William L. Maloy
Principal Civilian Advisor for
Education and Training
Naval Training Command, Code 00A
Pensacola, FL 32508

1 Dr. Kneale Marshall
Scientific Advisor to DCNO(MPT)
OP01T
Washington DC 20370

1 CAPT Richard L. Martin, USN
Prospective Commanding Officer
USS Carl Vinson (CVN-70)
Newport News Shipbuilding and Drydock Co
Newport News, VA 23607

1 Dr William Montague
Navy Personnel R&D Center
San Diego, CA 92152

1 Naval Medical R&D Command
Code 44
National Naval Medical Center
Bethesda, MD 20014

1 Mr. William Nordbrock
Instructional Program Development
Bldg. 90
NET-PDCD
Great Lakes Naval Training Center,
IL 60088

1 Ted M. I. Yellen
Technical Information Office, Code 201
NAVY PERSONNEL R&D CENTER
SAN DIEGO, CA 92152

Navy

1 Library, Code P201L
Navy Personnel R&D Center
San Diego, CA 92152

6 Commanding Officer
Naval Research Laboratory
Code 2627
Washington, DC 20390

1 Psychologist
ONR Branch Office
Bldg 114, Section D
666 Summer Street
Boston, MA 02210

1 Psychologist
ONR Branch Office
536 S. Clark Street
Chicago, IL 60605

1 Office of Naval Research
Code 437
800 N. Quincy SStreet
Arlington, VA 22217

5 Personnel & Training Research Programs
(Code 458)
Office of Naval Research
Arlington, VA 22217

1 Psychologist
ONR Branch Office
1030 East Green Street
Pasadena, CA 91101

1 Office of the Chief of Naval Operations
Research Development & Studies Branch
(OP-115)
Washington, DC 20350

1 LT Frank C. Petho, MSC, USN (Ph.D)
Code L51
Naval Aerospace Medical Research Laborat
Pensacola, FL 32508

1 DR. RICHARD A. POLLAK
ACADEMIC COMPUTING CENTER
U.S. NAVAL ACADEMY
ANNAPOLIS, MD 21402

Navy

1 Roger W. Remington, Ph.D
Code L52
NAMRL
Pensacola, FL 32508

1 Dr. Bernard Rimland (03B)
Navy Personnel R&D Center
San Diego, CA 92152

1 Mr. Arnold Rubenstein
Naval Personnel Support Technology
Naval Material Command (08T244)
Room 1044, Crystal Plaza #5
2221 Jefferson Davis Highway
Arlington, VA 20360

1 Dr. Worth Scanland
Chief of Naval Education and Training
Code N-5
NAS, Pensacola, FL 32508

1 Dr. Robert G. Smith
Office of Chief of Naval Operations
OP-987H
Washington, DC 20350

1 Dr. Alfred F. Smode
Training Analysis & Evaluation Group
(TAEG)
Dept. of the Navy
Orlando, FL 32813

1 Dr. Richard Sorensen
Navy Personnel R&D Center
San Diego, CA 92152

1 W. Gary Thomson
Naval Ocean Systems Center
Code 7132
San Diego, CA 92152

1 Dr. Robert Wisher
Code 309
Navy Personnel R&D Center
San Diego, CA 92152

Army

1 Technical Director
U. S. Army Research Institute for the
Behavioral and Social Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333

1 HQ USAREUE & 7th Army
ODCSOPS
USAAREUE Director of GED
APO New York 09403

1 DR. RALPH DUSEK
U.S. ARMY RESEARCH INSTITUTE
5001 EISENHOWER AVENUE
ALEXANDRIA, VA 22333

1 DR. FRANK J. HARRIS
U.S. ARMY RESEARCH INSTITUTE
5001 EISENHOWER AVENUE
ALEXANDRIA, VA 22333

1 Col Frank Hart
Army Research Institute for the
Behavioral & Social Sciences
5001 Eisenhower Blvd.
Alexandria, VA 22333

1 Dr. Michael Kaplan
U.S. ARMY RESEARCH INSTITUTE
5001 EISENHOWER AVENUE
ALEXANDRIA, VA 22333

1 Dr. Milton S. Katz
Training Technical Area
U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

1 Dr. Harold F. O'Neil, Jr.
Attn: PERI-OK
Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

1 Dr. Robert Sasmor
U. S. Army Research Institute for the
Behavioral and Social Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333

Army

1 Commandant
US Army Institute of Administration
Attn: Dr. Sherrill
FT Benjamin Harrison, IN 46256

1 Dr. Frederick Steinheiser
U. S. Army Reserch Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

1 Dr. Joseph Ward
U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

Air Force

1 Dr. Earl A. Alluisi
HQ, AFHRL (AFSC)
Brooks AFB, TX 78235

1 Dr. Genevieve Haddad
Program Manager
Life Sciences Directorate
AFOSR
Bolling AFB, DC 20332

1 Dr. Ross L. Morgan (AFHRL/LR)
Wright -Patterson AFB
Ohio 45433

1 Research and Measurment Division
Research Branch, AFMPC/MPCYPR
Randolph AFB, TX 78148

1 Dr. Marty Rockway (AFHRL/TT)
Lowry AFB
Colorado 80230

1 Jack A. Thorpe, Maj., USAF
Naval War College
Providence, RI 02846

Marines

1 H. William Greenup
Education Advisor (E031)
Education Center, MCDEC
Quantico, VA 22134

1 Director, Office of Manpower Utilization
HQ, Marine Corps (MPU)
BCB, Bldg. 2009
Quantico, VA 22134

1 DR. A.L. SLAFKOSKY
SCIENTIFIC ADVISOR (CODE RD-1)
HQ, U.S. MARINE CORPS
WASHINGTON, DC 20380

Other DoD

12 Defense Technical Information Center
Cameron Station, Bldg 5
Alexandria, VA 22314
Attn: TC

1 Dr. Craig I. Fields
Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, VA 22209

1 Dr. Dexter Fletcher
ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BLVD.
ARLINGTON, VA 22209

1 Military Assistant for Training and
Personnel Technology
Office of the Under Secretary of Defense
for Research & Engineering
Room 3D129, The Pentagon
Washington, DC 20301

Civil Govt

1 Dr. Susan Chipman
Learning and Development
National Institute of Education
1200 19th Street NW
Washington, DC 20208

1 Dr. Joseph I. Lipson
SEDR W-638
National Science Foundation
Washington, DC 20550

1 Dr. John Mays
National Institute of Education
1200 19th Street NW
Washington, DC 20208

1 William J. McLaurin
Rm. 301, Internal Revenue Service
2221 Jefferson Davis Highway
Arlington, VA 22202

1 Dr. Arthur Melmed
National Intitute of Education
1200 19th Street NW
Washington, DC 20208

1 Dr. Andrew R. Molnar
Science Education Dev.
and Research
National Science Foundation
Washington, DC 20550

1 Dr. H. Wallace Sinaiko
Program Director
Manpower Research and Advisory Services
Smithsonian Institution
801 North Pitt Street
Alexandria, VA 22314

1 Dr. Joseph L. Young, Director
Memory & Cognitive Processes
National Science Foundation
Washington, DC 20550

Non Govt

1 Dr. John R. Anderson
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213

1 DR. MICHAEL ATWOOD
SCIENCE APPLICATIONS INSTITUTE
40 DENVER TECH. CENTER WEST
7935 E. PRENTICE AVENUE
ENGLEWOOD, CO 80110

1 1 psychological research unit
Dept. of Defense (Army Office)
Campbell Park Offices
Canberra ACT 2600, Australia

1 Dr. Alan Baddeley
Medical Research Council
Applied Psychology Unit
15 Chaucer Road
Cambridge CB2 2EF
ENGLAND

1 Dr. Patricia Baggett
Department of Psychology
University of Denver
University Park
Denver, CO 80208

1 Mr Avron Barr
Department of Computer Science
Stanford University
Stanford, CA 94305

1 Dr. Nicholas A. Bond
Dept. of Psychology
Sacramento State College
600 Jay Street
Sacramento, CA 95819

1 Dr. Lyle Bourne
Department of Psychology
University of Colorado
Boulder, CO 80309

1 Dr. John S. Brown
XEROX Palo Alto Research Center
3333 Coyote Road
Palo Alto, CA 94304

Non Govt

1 Dr. Bruce Buchanan
Department of Computer Science
Stanford University
Stanford, CA 94305

1 Dr. Pat Carpenter
Department of Psychology
Carnegie-Mellon University
Pittsburgh, PA 15213

1 Dr. John B. Carroll
Psychometric Lab
Univ. of No. Carolina
Davie Hall 013A
Chapel Hill, NC 27514

1 Charles Myers Library
Livingstone House
Livingstone Road
Stratford
London E15 2LJ
ENGLAND

1 Dr. William Chase
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213

1 Dr. Micheline Chi
Learning R & D Center
University of Pittsburgh
3939 O'Hara Street
Pittsburgh, PA 15213

1 Dr. William Clancey
Department of Computer Science
Stanford University
Stanford, CA 94305

1 Dr. Allan M. Collins
Bolt Beranek & Newman, Inc.
50 Moulton Street
Cambridge, Ma 02138

1 Dr. Lynn A. Cooper
Department of psychology
Uris Hall
Cornell University
Ithaca, NY 14850

Non Govt

1 Dr. Meredith P. Crawford
American Psychological Association
1200 17th Street, N.W.
Washington, DC 20036

1 Dr. Hubert Dreyfus
Department of Philosophy
University of California
Berkely, CA 94720

1 LCOL J. C. Eggenberger
DIRECTORATE OF PERSONNEL APPLIED RESEARC
NATIONAL DEFENCE HQ
101 COLONEL BY DRIVE
OTTAWA, CANADA K1A 0K2

1 Dr. Ed Feigenbaum
Department of Computer Science
Stanford University
Stanford, CA 94305

1 Mr. Wallace Feurzeig
Bolt Beranek & Newman, Inc.
50 Moulton St.
Cambridge, MA 02138

1 Dr. Victor Fields
Dept. of Psychology
Montgomery College
Rockville, MD 20850

1 Dr. John R. Frederiksen
Bolt Beranek & Newman
50 Moulton Street
Cambridge, MA 02138

1 Dr. Alinda Friedman
Department of Psychology
University of Alberta
Edmonton, Alberta
CANADA T6G 2E9

1 DR. ROBERT GLASER
LRDC
UNIVERSITY OF PITTSBURGH
3939 O'HARA STREET
PITTSBURGH, PA 15213

Non Govt

1 Dr. Marvin D. Glock
217 Stone Hall
Cornell University
Ithaca, NY 14853

1 DR. JAMES G. GREENO
LRDC
UNIVERSITY OF PITTSBURGH
3939 O'HARA STREET
PITTSBURGH, PA 15213

1 Dr. Harold Hawkins
Department of Psychology
University of Oregon
Eugene OR 97403

1 Dr. Barbara Hayes-Roth
The Rand Corporation
1700 Main Street
Santa Monica, CA 90406

1 Dr. Frederick Hayes-Roth
The Rand Corporation
1700 Main Street
Santa Monica, CA 90406

1 Mr. Richards J. Heuer, Jr.
27585 Via Sereno
Carmel, CA 92923

1 Dr. James R. Hoffman
Department of Psychology
University of Delaware
Newark, DE 19711

1 Library
HumRRO/Western Division
27857 Berwick Drive
Carmel, CA 93921

1 Dr. Earl Hunt
Dept. of Psychology
University of Washington
Seattle, WA 98105

Non Govt

1 DR. LAWRENCE B. JOHNSON
LAWRENCE JOHNSON & ASSOC., INC.
Suite 103
4545 42nd Street, N.W.
Washington, DC 20016

1 Dr. Steven W. Keele
Dept. of Psychology
University of Oregon
Eugene, OR 97403

1 Dr. Walter Kintsch
Department of Psychology
University of Colorado
Boulder, CO 80302

1 Dr. Stephen Kosslyn
Harvard University
Department of Psychology
33 Kirkland Street
Cambridge, MA 02138

1 Mr. Marlin Kroger
1117 Via Goleta
Palos Verdes Estates, CA 90274

1 Dr. Jill Larkin
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213

1 Dr. Alan Lesgold
Learning R&D Center
University of Pittsburgh
Pittsburgh, PA 15260

1 Dr. Michael Levine
Department of Educational Psychology
210 Education Bldg.
University of Illinois
Champaign, IL 61801

1 Dr. Robert A. Levit
Director Behavioral Sciences
The BDM Corporation
7915 Jones Branch Drive
McClean, VA 22101

Non Govt

1 Dr. Robert Linn
College of Education
University of Illinois
Urbana, IL 61801

1 Dr. Mark Miller
Computer Science Laboratory
Texas Instruments, Inc.
Mail Station 371, P.O. Box 225936
Dallas, TX 75265

1 Dr. Allen Munro
Behavioral Technology Laboratories
1845 Elena Ave., Fourth Floor
Redondo Beach, CA 90277

1 Dr. Donald A Norman
Dept. of Psychology C-009
Univ. of California, San Diego
La Jolla, CA 92093

1 Dr. Jesse Orlansky
Institute for Defense Analyses
400 Army Navy Drive
Arlington, VA 22202

1 MR. LUIGI PETRULLO
2431 N. EDGEWOOD STREET
ARLINGTON, VA 22207

1 Dr. Martha Polson
Department of Psychology
University of Colorado
Boulder, CO 80302

1 DR. PETER POLSON
DEPT. OF PSYCHOLOGY
UNIVERSITY OF COLORADO
BOULDER, CO 80309

1 DR. DIANE M. RAMSEY-KLEE
R-K RESEARCH & SYSTEM DESIGN
3947 RIDGEMONT DRIVE
MALIBU, CA 90265

Non Govt

1 Dr. Fred Reif
SESAME
c/o Physics Department
University of California
Berkely, CA 94720

1 Dr. Andrew M. Rose
American Institutes for Research
1055 Thomas Jefferson St. NW
Washington, DC 20007

1 Dr. Ernst Z. Rothkopf
Bell Laboratories
600 Mountain Avenue
Murray Hill, NJ 07974

1 Dr. David Rumelhart
Center for Human Information Processing
Univ. of California, San Diego
La Jolla, CA 92093

1 PROF. FUMIKO SAMEJIMA
DEPT. OF PSYCHOLOGY
UNIVERSITY OF TENNESSEE
KNOXVILLE, TN 37916

1 DR. WALTER SCHNEIDER
DEPT. OF PSYCHOLOGY
UNIVERSITY OF ILLINOIS
CHAMPAIGN, IL 61820

1 Dr. Alan Schoenfeld
Department of Mathematics
Hamilton College
Clinton, NY 13323

1 DR. ROBERT J. SEIDEL
INSTRUCTIONAL TECHNOLOGY GROUP
HUMRRO
300 N. WASHINGTON ST.
ALEXANDRIA, VA 22314

1 Committee on Cognitive Research
% Dr. Lonnie R. Sherrod
Social Science Research Council
605 Third Avenue
New York, NY 10016

Non Govt

1 Dr. Robert Smith
Department of Computer Science
Rutgers University
New Brunswick, NJ 08903

1 Dr. Richard Snow
School of Education
Stanford University
Stanford, CA 94305

1 Dr. Robert Sternberg
Dept. of Psychology
Yale University
Box 11A, Yale Station
New Haven, CT 06520

1 DR. ALBERT STEVENS
BOLT BERANEK & NEWMAN, INC.
50 MOULTON STREET
CAMBRIDGE, MA 02138

1 Dr. David Stone
ED 236
SUNY, Albany
Albany, NY 12222

1 DR. PATRICK SUPPES
INSTITUTE FOR MATHEMATICAL STUDIES IN
THE SOCIAL SCIENCES
STANFORD UNIVERSITY
STANFORD, CA 94305

1 Dr. Brad Sympson
Psychometric Research Group
Educational Testing Service
Princeton, NJ 08541

1 Dr. Kikumi Tatsuoka
Computer Based Education Research
Laboratory
252 Engineering Research Laboratory
University of Illinois
Urbana, IL 61801

1 Dr. John Thomas
IBM Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598

Non Govt

1 DR. PERRY THORNDYKE
THE RAND CORPORATION
1700 MAIN STREET
SANTA MONICA, CA 90406

1 Dr. Douglas Towne
Univ. of So. California
Behavioral Technology Labs
1845 S. Elena Ave.
Redondo Beach, CA 90277

1 Dr. J. Uhlaner
Perceptronics, Inc.
6271 Variel Avenue
Woodland Hills, CA 91364

1 Dr. Benton J. Underwood
Dept. of Psychology
Northwestern University
Evanston, IL 60201

1 Dr. Phyllis Weaver
Graduate School of Education
Harvard University
200 Larsen Hall, Appian Way
Cambridge, MA 02138

1 Dr. David J. Weiss
N660 Elliott Hall
University of Minnesota
75 E. River Road
Minneapolis, MN 55455

1 Dr. Keith T. Wescourt
Information Sciences Dept.
The Rand Corporation
1700 Main St.
Santa Monica, CA 90406

1 DR. SUSAN E. WHITELY
PSYCHOLOGY DEPARTMENT
UNIVERSITY OF KANSAS
LAWRENCE, KANSAS 66044

1 Dr. J. Arthur Woodward
Department of Psychology
University of California