Interest as a Function of Knowledge

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Abstract

Two experiments demonstrated that a reader's interest in a text is affected by the relationship of the text's content and the reader's knowledge. Subjects acquired knowledge in a domain and then read and rated texts designed to have a variety of relationships with that knowledge. Understandability was shown to be a necessary but not a sufficient condition for interest. Furthermore, the degree of relatedness between text content and reader knowledge affected interest, and texts which clarified confusions or ambiguities for a reader were judged interesting.

Interest as a Function of Knowledge

Philosophers, educators and psychologists have long recognized interest as a facilitator of learning, memory and comprehension, especially in reading (Bartlett, 1932; Berlyne, 1960, 1965; Davidson, 1898; Frankena, 1965; Howie, 1969; James, 1890; Woodward, 1904). Experiments abound which demonstrate that the interested learn to read quicker and retain and comprehend what they read better than the uninterested (e.g., Asher, Hymel & Wigfield, 1978; Belloni & Jongsma, 1978; Bernstein, 1955; Carter, 1978; Frasher & Frasher, 1978), and interest-based strategies are often recommended for reading and study programs (Estes & Vaughan, 1973; Frasher, 1978; Macklin, 1978; Pauk, 1973, 1974).

Theories of cognitive processes have taken interest's facilitative effects into account (e.g., Kintsch, 1980; Maslow, 1954; Piaget, 1952; Schank, 1978). For instance, Schank (1978) proposed that interest might provide direction to and thereby limit the amount of inferencing required for text comprehension. Kintsch (1980) suggested that cognitive interests might be a factor determining which propositions in a text base are important in the formation of a macrostructure of a text. Most of these theories include speculations or assumptions about why some things are and others are not interesting, and some suggest answers to the question of why interest is correlated with improved

learning and comprehension. But little empirical work has focused on these two questions. Experiments which dealt with the first of these two issues are presented in this paper. Ideas relevant to the second are also briefly discussed.

Interest may have many sources. Some things appear to be inherently interesting (Schank, 1978). Others are interesting only in certain contexts and to some people. Surprise may make otherwise uninteresting events interesting (Walker & Kintsch, forthcoming). The relationship between the reader's knowledge and a text may also play a role in arousing interest, and that will be the focus of this paper.

Knowledge-generated interest

At the most basic level, the understandability of a text is a necessary, but not a sufficient, condition for interest. The reader who cannot understand a text will not find it interesting, but comprehensibility does not guarantee interest. The reader's knowledge figures importantly here, for a reader with inadequate background knowledge will not understand a text. Incomprehenisibility can result from a variety of other factors too (e.g., bad writing style or poor organization of the text).

More broadly, the degree to which the content of a text is related to the reader's knowledge appears to be important. That is, the extent to which the propositions in the text directly or via inference match the reader's

knowledge may in part determine how interesting the text is for that reader. At one extreme the text propositions and the reader's knowledge are totally unrelated, and the text is incomprehensible and therefore quite boring, as discussed above. At the other extreme the text is quite comprehensible but uninteresting because it is completely redundant in the context of the reader's knowledge, it tells the reader nothing new. It is between these extremes that interest emerges. Here, a sufficient number of text propositions are known to the reader so that comprehension can occur. Already-known propositions and word concepts are retrieved from long-term memory as they are encountered, and it is in the context of these propositions and other, related propositions already in memory that comprehension of new information occurs. A plot of interest against relatedness should therefore be nonmonotonic, something like an inverted-U function.

In addition, if a text contains information that answers questions, clears up confusions or fills in gaps in the reader's knowledge, interest might result. This is particularly so if the questions, confusions, or gaps in knowledge have been problematical for the reader.

If an article's content conflicts or disagrees with the reader's knowledge, the impact on interest is less clear. It probably depends on variables like emotional investment in already-held beliefs, and ability to cope with ambiguity,

uncertainty and cognitive dissonance. Presumably, knowledge conflicts of an impartial, unemotional sort produce interest.

Experiment 1

In order to test whether interest is related to knowledge as described above, an experiment was conducted in which one group of subjects learned about steam locomotives and another learned about passenger services found on 19th century American railroads. Both the steam-trained and passenger-trained subjects later read ten articles related to the knowledge acquired during training in one of the several ways thought to affect interest. Five of the articles dealt with locomotives (steam-related) and five dealt with passenger services (passenger-related).

Within each set of five articles, one was designed to be extremely familiar and hence less interesting in the context of knowledge acquired by subjects who received related training. A second article was written to be incomprehensible and hence uninteresting to all subjects. Another text within each set of five was written to provide related but new information, a fourth answered questions or clarified ambiguities, and the fifth article was written to conflict with information acquired during related training. These last three were intended to induce interest.

Method

Subjects. Forty-eight introductory psychology students

satisfied a course requirement by participating in the experiment. They were randomly divided into two groups of 24 subjects.

Materials. During the training session, the training text was presented to the subject on a IV Phase cathode ray tube (CRT) using a Xerox Sigma-3 computer. Each training text was 57 CRT screens (approximately 6800 words) in length.

The knowledge-text relationships which defined the pairs of experimental texts are described below. The median length of these articles was 460 words.

Highly familiar texts were created by abstracting short texts from the training materials. These articles were primarily restatements of information contained in the training materials. To assure that subjects would find these texts familiar, an adjunct question was placed in the training text following the initial explanation of the material targeted to be highly familiar. To answer it, subjects had to summarize the material they had just finished reading. When their answers were completed they read a sample answer with which they could compare their own.

Texts which contained related, but new information simply presented new information which built directly on facts initially presented in the training text.

Incomprehensible texts were highly technical articles.

A complete understanding of them required a vocabulary and conceptual base unavailable to the subjects.[Footnote 2]

Texts which clarified confusions for the reader contained information required for complete understanding of the training text but not possessed by subjects. An adjunct question was placed in the training text and required subjects to explain this unknown information. Of course, they could not answer the question, which is what we wanted them to realize. No sample answer was provided.

The text which conflicted with subjects' knowledge presented as true information which the related training text indicated was false. An adjunct question in the training text required subjects to assert the falsehood of the information which the experimental text presented as true. A sample answer was provided.

A 16-item, five-alternative, multiple choice quiz was developed for each training text and used to assess training effectiveness. A 32-item quiz was formed by combining the questions of the two smaller quizzes in a random order. With this quiz it was possible to assess both training effectiveness and baseline knowledge for each training topic.

Procedure. Subjects participated in groups of up to four during the same 1.5 hour period on two consecutive days. The first day of the experiment was a training session during which subjects learned something about 19th

century passenger services or steam locomotives on American railroads. They were instructed that three adjunct questions designed to monitor their learning of the material would appear at arbitrary points in the text and that they were to write their answers on paper provided. Subjects paced themselves through the training session by pressing a key on the CRT's console to call up successive screens. When finished reading the training text, they were immediately given a surprise quiz to assess how well they had learned the materials.

Within each training group 12 subjects received the 32-item quiz and 12 recieved the 16-item quiz relevant to training received. The 32-item quiz was not given to all subjects because exposure to questions not based on training received might have stimulated curiosity about the topics dealt with in these questions. "Quiz" was entered as a factor in initial data analyses to check on this possibility.

In the experimental session, given on the second day, subjects read ten texts in two groups of five, with a short rest between groups. They rated each text on five different dimensions using a seven-point rating scale, where one indicated "not at all" and seven indicated "very much so" in answer to a question used to indicate each rating dimension.

The questions which cued the dimensions on which the texts were rated were:

Familiarity rating: "Was this article mostly a reworking of things you already knew?"

Interest rating: "Was this article interesting?"

Understandability rating: "Was this article understandable?"

Clarification rating: "Did this article clear up any confusions you might have had about railroads? (Provide you with information that made things make more sense?)"

Match-to-knowledge rating: "Is this article closely related to what you already know about railroads? (Does it tie in well with what you already know?)"

The ratings were done on mimeographed scales in the order in which the questions appeared on the CRT after each text. The ratings provided information about the nature of the knowledge-text relationships which resulted from the training procedures and experimental texts used as well as the interestingness of the experimental texts. No conflict ratings were collected in this experiment, but such ratings were collected in Experiment 2.

Each subject did the five ratings in a different random order for each text and read the five texts of each set in a different random order. The order in which the sets of passenger- and steam-related texts were read was counterbalanced within each training group.

Design. The overall design of the experiment was as follows. Three two-level, fixed, between-subjects factors

were completely crossed. The between-subjects factors were training condition (steam- versus passenger-training), quiz (16-item versus 32-item quiz), and order of set presentation on the second day (the set of five passenger-related articles first, followed by the set of five steam-related articles, or vice-versa). Two fixed, repeated-measure factors were also crossed with the other variables: type of article (steam- versus passenger-related) and knowledge-text relationship (familiarity, related-new, incomprehensible, clarification and conflict).

Results

Training effectiveness. The 32-item quiz was scored as two separate 16-item quizzes, yielding a steam- and passenger-quiz score for those subjects who took it. Steam-trained subjects did better on the steam quiz (mean number of items correct = 9.3) than did passenger-trained subjects (mean = 3.0), $t(34) = 7.80$, $p < .001$, and pasenger-trained subjects (mean = 11.5) outperformed steam-trained subjects (mean = 4.3) on the passenger quiz, $t(34) = 9.51$, $p < .001$.

Ratings. An attempt was made to construct the experimental texts so that each would be related to the knowledge of readers who received related training in only one of the ways in which we were interested. The very nature of the relationships being investigated precluded this, however, and analyses of the familiarity,

understandability, clarification and match-to-knowledge ratings revealed interdependencies among the relationships. For instance, texts rated high on familiarity were also given high match-to-knowledge ratings, and texts rated high on clarification were also rated high on both familiarity and match-to-knowledge. These interdependencies precluded unambiguous interpretations of an analysis of variance of the interest ratings, so a multiple regression approach was used to analyze these data. Neither the quiz nor the presentation order factors interacted with the text type or relationship factors in the analysis of variance of the interest ratings, so all ratings were used in the regression analyses.

Regression analyses. The bivariate correlations entered into the regression analyses are presented in Table 1. All correlations were significant (ps $\leq$ .018).

Table 1 about here.

To check the significance of the expected quadratic (inverted-U) relationship between interest and the relatedness continuum, which was represented by the match-to-knowledge and familiarity ratings, interest was regressed on these two variables and their squares. The multiple correlation coefficient when interest was regressed on familiarity alone was .148. The addition of

familiarity-squared increased the proportion of explained variance in the interest ratings two percent (R grew to .213), a significant albeit small increase $F(1,477) = 11.74$, $p < .001$. A directly analogous but marginally significant quadratic effect was found for the relationship between interest and match-to-knowledge. When match-to-knowledge--squared was added to match-to-knowledge, the increase in the percentage of predictable variability in interest was one percent (R grew from .296 to .307), $F(1,477) = 3.48$, $p = .063$. These quadratic relationships are plotted in Figure 1.

Figure 1 about here.

In these data the largest bivariate correlation was that between interest and understandability, $r = .584$. The magnitude of this correlation was in part due to the large range in the understandability of the texts used in the experiment. In Figure 1, the incomprehensible texts are those given the lowest mean understandability and interest ratings. When ratings of the incomprehensible texts were excluded from the calculations, the correlation of interest and understandability dropped to .498.

Understandability is best thought of as a necessary condition for interest. Our primary concern was with predictors of interest beyond this basic necessary

condition, so interest was regressed on the ratings of clarification, familiarity, match-to-knowledge, and the square of the last two of these. $R = .484$, $F(3,476) = 48.44$, $p < .001$, when clarification and match-to-knowledge and its square entered the multiple regression equation, in that order. Match-to-knowledge added one percent to the 21 percent of the variability in interest accounted for by clarification, $F(1,477) = 7.96$, $p = .005$, and match-to-knowledge--squared added another one percent to the explained variability in interest, $F(1,476) = 5.23$, $p < .025$. No other predictors entered the equation.

Ten sets of ratings were entered into these regression analyses for each subject. To assure that the obtained correlations were not due to differences across subjects in the use of the rating scales, subject identity was dummy coded and forced into the regression equation before the predictor ratings. In the resulting regression analyses the pattern of relationships reported above emerged and remained significant.

A discussion of the results of Experiment 1 will follow the presentation of Experiment 2.

Experiment 2

Method

The methods of Experiment 2 were identical to those of Experiment 1 with the following modifications and extensions. In Experiment 1 the lack of conflict ratings

precluded verification of the conflict relationship and the entry of conflict as a predictor in the multiple regression analysis. Subjects rated conflict in Experiment 2, and the question used to cue the rating was "Did this article conflict with what you already knew about railroads? If you assume everything in it is true, does it alter or change your knowledge about railroads in any way (as opposed to simply adding new information)?"

The second experiment was not run on a computer. All instructions and texts were presented in a folder, typed on 8.5 by 11 inch sheets of paper. Questions that cued second-day ratings were presented on a sheet of paper too, following each text. Ratings were done as in Experiment 1. In Experiment 2 all subjects received only the 16-item quiz relevant to training received, thus removing quiz as a factor in the experimental design. Subjects were run in groups of up to six.

Subjects. Forty introductory psychology students satisfied a course requirement by participating in the experiment. They were randomly divided into two groups of 20 subjects.

Results

Training effectiveness. The mean score of the steam-trained subjects of Experiment 2 on the steam quiz was 9.1, which did not differ significantly from that of the steam-trained subjects of Experiment 1, $t(42) = .04$, $p >$

.05. The mean score of the passenger-trained subjects of Experiment 2 on the passenger quiz was 10.6, which did not differ significantly from the performance of passenger-trained subjects of Experiment 1, $t(42) = 1.37$, $p > .05$.

Regression analyses. The bivariate correlations entered into the regression analyses are presented in Table 2. The pattern of intercorrelations was the same as that found in Experiment 1.

Table 2 about here.

The quadratic relationships between interest, on the one hand, and match-to-knowledge and familiarity, on the other, reported in Experiment 1 were also found in Experiment 2, and are plotted in Figure 1. The addition of familiarity-squared added two percent to the percentage of the variability in interest explained by familiarity alone (R grew from .11 to .17), $F(1,397) = 7.73$, $p = .006$. When their square was added to the match-to-knowledge ratings, the percent of variability in interest explained increased two percent (R grew from .21 to .26), $F(1,397) = 8.93$, $p = .003$.

The correlation of interest and understandability in Experiment 2 was .603. When the incomprehensible texts were dropped from the analysis, r dropped to .463, demonstrating

that the large range in the understandability of the texts used contributed greatly to the correlation.

For the same reasons outlined in the presentation of the results of Experiment 1, interest was regressed on the ratings of clarification, familiarity, match-to-knowledge, and the square of the last two of these. Conflict ratings were not included because of their nonsignificant correlation with interest. $R = .408$, $F(3,396) = 25.35$, $p \leq .001$, when clarification and match-to-knowledge and its square entered the equation in that order. Clarification accounted for 12 percent of the variability in interest, and match-to-knowledge and its square accounted for an additional 3 and 1 percent, respectively. The increases in R were significant when match-to-knowledge, $F(1,397) = 11.84$, $p < .001$, and its square, $F(1,396) = 6.20$, $p = .013$, were added to the equation. No other variables entered the equation.

Discussion

The second experiment replicated the first in all important respects, so in the discussion that follows they will be discussed as one. Before discussing the results of the regression analyses it should be pointed out that the correlations between interest and the predictor variables stemmed only partially from the knowledge-text relationships resulting from the training procedures and experimental texts used. Subjects consistently identified differences in

interest, understandability, clarification, familiarity, match-to-knowledge and conflict across the pairs of texts which were defined on the relationships being considered. Similarly, they reliably identified differences in the interest and understandability of the steam- versus passenger-related texts. Apparently subjects entered the experiment with sufficient knowledge about railroads to enable them to reliably rate and differentiate the texts on the rating scales used.

These experiments demonstrated that understandability is a necessary condition for interest. Incomprehensible texts were judged uninteresting. Although comprehensible texts were judged more interesting, there was quite a bit of variability in the interestingness of these remaining texts, suggesting that understandability alone is insufficient to explain interest.

These experiments also demonstrated that if a text answers questions or clarifies confusions for a reader it will be interesting. For the texts used, as the clarifying power of a text increased, so did its interest level. The correlation of the clarification and interest ratings was second only to that of interest and understandability.

Conflict was not related to interest in these experiments, perhaps because the conflicting information in the experimental texts was presupposed. Reader's tend to accept presupposed information as true (Hornby, 1974), so it

may be that they simply did not notice the conflict of the new information with the material they had learned the previous day.

When interest was regressed on clarification, match-to-knowledge, familiarity, and the square of the last two of these, only clarification and match-to-knowledge and its square were needed to optimize prediction of interest. Clarification and relatedness (represented by match-to-knowledge and its square) accounted in part for independent portions of the variaiblity in interest, demonstrating the partial independence of these two types of knowledge-text relationship.

In summary, interest is in part determined by the relationship between a reader's knowledge and the content of a text. Understandability is unquestionably a necessary but not a sufficient condition for interest. Beyond this, the degree to which a text is related to the reader's knowledge affects interest. As relatedness increases, so does interest, but only to a point -- then interest decreases as relatedness continues to grow. And beyond these two factors, if a text clarifies something for the reader, interest is greater.

Although these experiments were not designed to elucidate why interest is correlated with improved comprehension and learning (indeed, measures of comprehension and learning were not collected), their

results lead to some useful speculations in that direction. One might argue, as would some educational researchers, that these manipulations increased interest, and that interest in turn would somehow improve performance. Such an argument does not tell us what it really means to be interested, however, nor does it tell us how this state facilitates performance. But if one considers the kind of processing which is occuring with the texts used in these studies, one arrives at a much more direct and plausible explanation of why performance improves with interest and an idea of what it means to say that a reader is cognitively interested.

Interest decreases at the extremes of the relatedness continuum, and there is good reason to believe that processing does too. The words and sentences of incomprehensible texts cannot be semantically encoded because the concepts they represent are not held by the reader. The reader who attempts to read an incomprehensible text will waste his efforts on meaningless surface and syntactic processing and probably will not continue for long. If, on the other hand, all of the content of the text is already known to the reader, there is really no need for detailed, deep semantic processing. Shallow confirmatory monitoring of the text's content will do, and little or no inferencing occurs. Few of the reader's resources are required.

But in the middle of the relatedness continuum,

relevant knowledge possessed by the reader must be used during reading, for it enables the inferencing which is required for comprehension of new information. The reader, of course, has to allocate substantial resources to this kind of processing.

Given the foregoing, the reader's active processing should be maximal for texts which fall in the middle of the relatedness continuum. Comprehension is the processing described, and, as indicated, processing is at a maximum in the middle of the continuum. The peak in processing also accounts for the peak in learning. According to Kintsch and van Dijk (1978), the more processing a proposition receives (i.e., the more processing cycles through which it passes), the greater the probability that it will be stored in long term memory. The substantial inferencing occasioned by texts in the middle of the relatedness continuum centers on new information, and so this information will likely be learned.

Notice that interest peaks when processing (especially inferencing) is at a maximum. Perhaps the phenomenon of being cognitively interested is simply the experience of allocating much of one's resources to the reading task. Is cognitive interest equivalent to cognitive absorption in one's task? Cognitive interest may not cause improved performance, but, rather, it may result from the kind from processing which by its very nature should also result in

better performance on learning and comprehension tasks.

Texts that fill in troublesome gaps in the reader's knowledge fall in the middle of the relatedness continuum, so they should result in improved learning and comprehension and higher cognitive interest. But because new information clarifies confused relationships among elements in preexisting knowledge, or fills in disconcerting gaps in that knowledge, the effect on interest goes beyond that resulting from simply providing new, related information. That this is so is attested to by the independent contributions of clarification and relatedness to the prediction of interest in Experiments 1 and 2. In this case more than a simple accretion of knowledge occurs. Processing of this kind of information consists of modifying, confirming and/or adding to preexisting knowledge. A heavy involvement of retrieval and inferential processes can be assumed, yielding both improved task performance and higher interest.

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Footnotes

1. This research was supported by grant 15872 from the National Institute of Mental Health to W. Kintsch.

2. A brief word about the lexical and semantic components of understandability is in order. A reader who does not have a command of the lexicon used in a text will not understand it, but that does not necessarily mean the concepts prerequisite to understanding are absent. On the other hand, the reader who does not have a command of the concepts prerequisite to understanding simply cannot understand, no matter what vocabulary is used. In terms of the overall relatedness continuum, the lexical component of understandability is a somewhat superficial example of the failure of a text to interface well with the reader's knowledge. The failure is lexical, not necessarily semantic. The semantic component refers to the text-knowledge interface in a much richer sense. The absence of the conceptual prerequisites for comprehension means that the reader lacks the knowledge structures within which the text can be comprehended. The incomrehensible manipulation in Experiments 1 and 2 relied on the lack of the semantic and therefore also the lexical components.

Table 1

Product-Moment Correlation Coefficients Among the Variables Entered into the Regression Analyses of Experiment 1

	Understand-ability	Match-to-Knowledge	Match-to-Knowledge Squared	Familiarity	Familiarity Squared	Clarification
Match-to-Knowledge	.28					
Match-to-Knowledge Squared	.27	.98				
Familiarity	.23	.58	.61			
Familiarity Squared	.22	.54	.59	.97		
Clarification	.38	.42	.41	.28	.22	
Interest	.58	.30	.27	.15	.11	.46

Note. All ps $\leq$ .018; number of cases = 480.

Table 2

Product-Moment Correlation Coefficients Among the Variables Entered into the Regression Analyses of Experiment 2

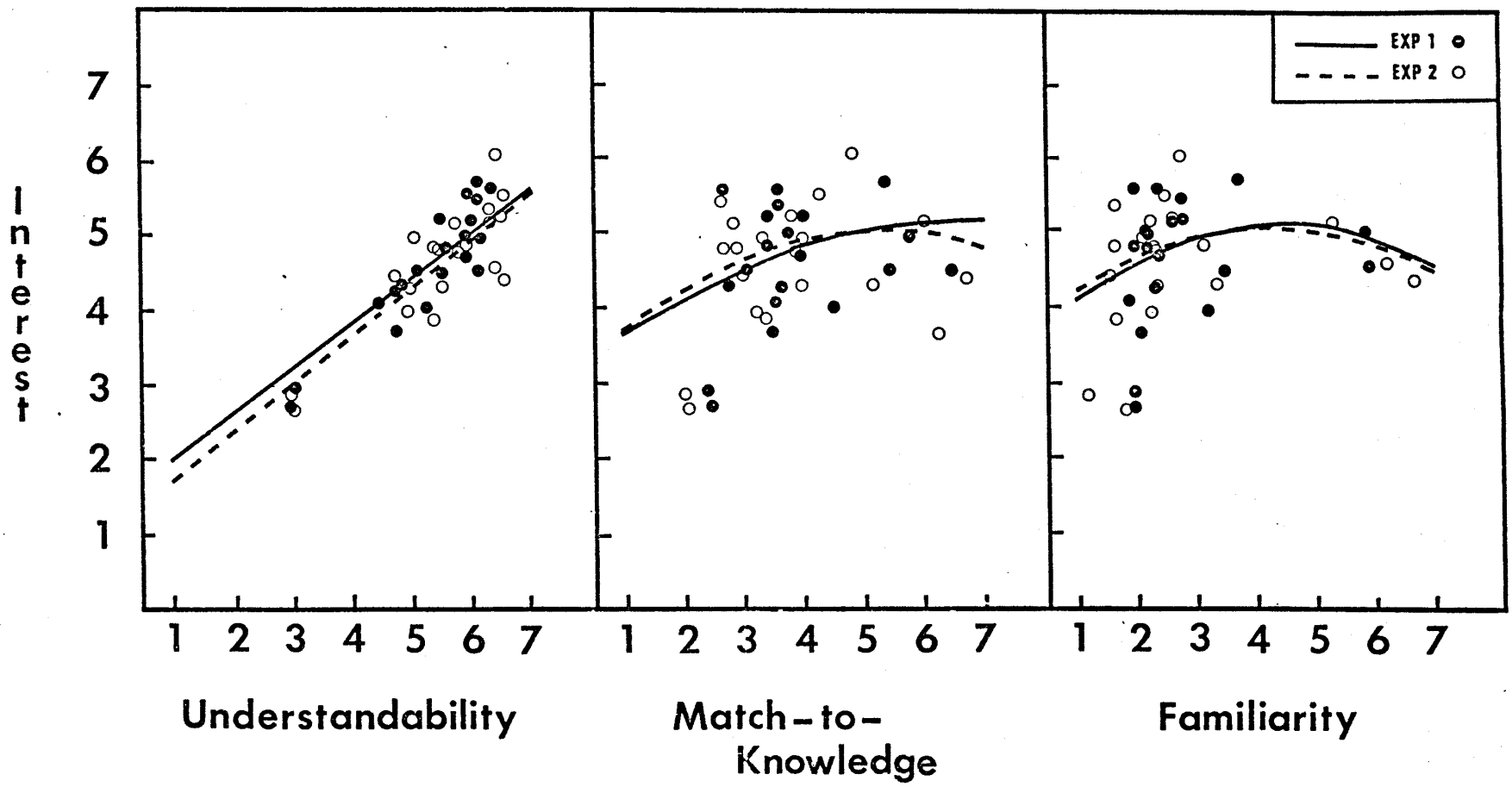
	Understandability	Match-to-Knowledge	Match-to-Knowledge Squared	Familiarity	Familiarity Squared	Clarification	Conflict
Match-to-Knowledge	.41						
Match-to-Knowledge Squared	.39	.98					
Familiarity	.30	.66	.69				
Familiarity Squared	.28	.64	.68	.98			
Clarification	.26	.16	.14	.17	.11		
Conflict	-.07	-.08	-.12	-.09	-.14	.06	
Interest	.60	.21	.18	.10	.07	.35	-.04

Table 2, Continued

Note. For correlations not involving conflict, $ps \leq .037$, except for the correlation of interest and familiarity squared, $p = .148$. Conflict correlated significantly only with match-to-knowledge squared and familiarity squared, $ps \leq .017$. Number of cases = 400.

Figure Captions

Figure 1. Plot of interest against understandability, match-to-knowledge and familiarity, Experiments 1 and 2. The line graphs are plots of the multiple regression equations, and the points are mean interest ratings by mean understandability, match-to-knowledge and familiarity ratings given to the texts by subjects of the steam and passenger service training groups.


EXP 1
EXP 2
Interest
7
6
5
4
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2
1
1 2 3 4 5 6 7
Understandability
Match-to-Knowledge
Familiarity