Text Synthesis, Feedback, and Retrieval

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Technical Report No. 137

Institute of Cognitive Science

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February, 1985

ABSTRACT

Subjects reconstructed two sets of scrambled discourse consisting of 26 sentences each. Subjects were given either no feedback or limited feedback as confirmation-disconfirmation, with retrieval either immediate or delayed one week. Memory was measured in terms of recall of idea units and recognition of original sentences from paraphrases. Concordance was measured by relationship to the original sentence order. Recall scores were not related to any of the independent variables, while recognition scores were related to content. The data suggest a modest contribution of feedback to concordance, but this did not result in achievement differences. The findings replicate previous research which suggests that subjects used feedback to assist idiosyncratic strategies and knowledge using local syntactical cues and coherence. In terms of instructional development appropriate feedback appears to be more situation-specific than previously assessed.

Instructional developers consider feedback to be a critical adjunct aid to learning (e.g., Anderson & Faust, 1973). Indeed, everyday experiences would confirm that given some assistance and direction, most learners benefit. Generally, feedback is used to adjust differences between the content of the instructional program developer and perceived student outcomes. Almost invariably feedback is assumed to follow the student response with a direct and predictable effect; i.e., assisting the learner in establishing a higher degree of concordance between learning outcomes and the a priori logic of the author. However this may be a naive assumption. Validation of any process based upon a product (i.e., a response) is difficult, since one has to prove that there was no other way the learner could have derived the response (Winne, 1982; Bilodeau, 1969).

Nevertheless, a basic assumption in most text processing is that the organization of the discourse, either at the syntactical or conceptual level is critical for such typical memory measures as recall and recognition (Reder, 1980). It is easy to understand why researchers consider learner schemata critical to processing, either facilitating or interfering with the objectives of the program (Brooks & Dansereau, 1983). However, theoretical models in discourse processing are not yet fully developed so as to provide a comprehensive practical framework for the sequencing of text (e.g., Kintsch & van Dijk, 1978; van Dijk & Kintsch, 1983; Meyer & Freedle, 1984). Learning, therefore, appears to be the product of an interaction between unknown, idiosyncratic learner schemata and some set of discourse processing strategies, resulting in varying levels of achievement.

Current feedback models do not clarify these problems, since feedback itself is a controversial issue. The major theoretical argument is clearly the information-incentive controversy. Starting with the work of Thorndike (1932) the behaviorists have viewed feedback as reinforcing and part of the

conditioning process. This equivalency of feedback to reinforcement (e.g., Gagne, 1984) is essential to a view of learning based on deterministic transformations of input (Langer & Keenan, 1984).

In contrast, the cognitive position (Atkinson & Wickens, 1971), assumes that the information provided contributes directly to the immediacy and direction of change. The idiosyncratic transformation of data is a given. Unfortunately for the cognitive position, the issue of feedback has scarcely been addressed in instructional terms (Clark, 1982).

Along with the theoretical controversy regarding how feedback works, a second major issue deals with the fact that operationally feedback is a multi-factor construct (Holding, 1965). A meta-analysis of concept acquisition in children (Getsie, Langer, & Glass, 1985) found the major experimental feedback parameters to include timing, i.e., immediate-delayed, and form, i.e., symbolic, verbal, and tangible. One of the most significant findings was that interaction effects generally exceeded main effects.

The simultaneous and still vaguely defined interaction of discourse strategies, learner schemata, and feedback is not amenable to a simple explanation. In the past researchers have tried to restrict the problem by the use of artificial texts, since research findings reveal that recall is subject to the logic of the discourse (e.g., Frase, 1969; Kulhavy, Schmid, & Walker, 1977; Taylor & Samuels, 1983). On the other hand, Anderson and Reder (1979) argue that the schemata available to the learner may impact acquisition more than the discourse logic itself. However, this acknowledges that learner schemata, which are generally unknown, are not necessarily under the control of the discourse logic (Langer, Keenan, & Medosch-Schonbeck, 1984).

It was our belief that feedback could be analyzed using a somewhat different research paradigm. First of all, we accepted Kulhavy's (1977)

premise that the more qualitative aspects of feedback such as timing and type have not been analyzed in any great detail. We decided to explore these factors in a more sensitive manner, using a text format in which the learner was less restricted as to idiosyncratic processing. Sternberg and Ketron's (1982) findings support the conclusion that a predetermined feedback strategy may not assist a functional, but unique student-generated processing.

This led the decision to use disconnected rather than structured discourse. The assumption was that the lack of an immediately apparent organization would encourage individual strategies, making feedback more sensitive to individual schemata and developing text logic. The feedback provided was a limited confirmation-disconfirmation paradigm, based on the original order of sentences. We hoped this would force the subjects to rely more heavily on their cognitive resources, and concomitantly utilize feedback more efficiently in terms of their own needs (Langer, & Keenan, 1984).

In the end we expected a reconstructed discourse bearing some relationship to the original text, but not necessarily identical. Our measures of achievement could therefore be used to determine just how concordance was related to retrieval. In short, if we provided feedback which assisted, but did not overwhelm the learner's processing strategies, was the resulting lack of concordance detrimental to performance?

Overall, scrambled discourse provides a level of meaningfulness located somewhere between nonsense syllables and tightly structured discourse. Research problems in this area have dealt with meaningfulness (Bruning, 1970), programmed instruction (Tobias, 1973; Brown, 1970), and sentence interrelatedness (Kissler & Lloyd, 1973). As one might expect, scrambled discourse yields poorer performance than connected discourse regardless of

unit size (Dansereau, Evans, Wright, Long, & Atkinson, 1973). In most experiments involving scrambled presentation, little is done to assist the learner. However, in a study by Schultz and DiVesta (1972) subjects were allowed to take notes. The researchers observed that students modified the passages to suit their needs.

Our previous research (Langer & Keenan, 1984; Keenan, Langer, & Medosch-Schonbeck, 1985) has yielded relatively few consistent results. Our findings do generally support Clark's (1973) assumptions that content should be treated as a random rather than a fixed variable. Both content and passage length are differentially impacted by feedback. Second, recognition rather than recall seems to be more sensitive to our procedures (Keenan, Langer, & Medosch-Schonbeck, 1985). Finally, while concordance (tau) is improved by feedback, this does not contribute to improved retrieval. Instead, local coherence and syntactical cues appear to play an important but as yet not precisely defined role. In short, utilization of feedback does not seem to follow the previously generally accepted guidelines. The results of the first two studies led us to conduct this third experiment, utilizing materials of differing familiarity. We wanted to address the text synthesis strategy with significant differences in available learner schemata, using limited feedback.

Procedures

The subjects were 48 Fall 1984 undergraduate students from the Introductory Psychology course at the University of Colorado. They were given the task on an individual basis, with order of treatments randomly assigned.

Again, following Clark's (1973) argument, content was treated as a random rather than a fixed variable. His recommendations have generally been ignored, at least in the literature on the instructional use of

feedback. Two 26-sentence passages were used. One was drawn from Laura Fermi's account of the building of the first nuclear pile in the development of the atom bomb, (Fermi, 1957), although the phrase "atom bomb" never appears per se in the passage. The second was taken from Woodward and Bernstein's (1976) account of the last year of Nixon's administration, and details the content of a Nixon tape ordering his aides to stonewall the Watergate investigation. The initial operating assumption was the Watergate investigation would be much more familiar to our subjects. The Fermi passage is given in Appendix A, while the Nixon materials are found in Appendix B.

Within both passages each sentence was typed separately on a 3x5 index card. To assist subjects in ordering the sentences, a wooden board with 35 slots was constructed, providing space for one card. The cards were picked up by the subject one at a time, read, and placed in a slot. This forced serial processing and provided direct observation of each subsequent placement decision.

Each of the two passages was randomly ordered. The subjects were further randomly assigned into feedback and no-feedback groups. Half the subjects took the achievement measures immediately, while the other half delayed a week (but were not warned of the memory measures). The final factorial design was 2 (Fermi or Nixon passage) x 2 (feedback - no-feedback) x 2 (immediate - delayed). The cells were balanced as to number of subjects. The subjects were informed that the purpose of the experiment was to determine how people made meaning from material they read, particularly how meaning is constructed. To familiarize them with the experimental task, they first performed a practice task which consisted of reordering 11 sentences comprising the story of "The Goose that Laid the Golden Egg." As in the experiment proper, each card contained a single sentence, with the

order of cards scrambled. The subjects were told to reorder the sentences to make the best complete story, and signal when they felt the story was complete. All questions regarding procedures were answered at this time.

If the subject was to receive the feedback treatment on the experimental passage to follow, the experimenter gave the subject five tokens to be used for feedback during the practice task. The experimenter informed the subject that on giving up a token, they would be told if a card had been placed correctly. Thus, help was provided up to a maximum of five requests.

The subject was informed of the meaning of a "yes" or "no" with respect to card position. The subject was told that a "yes" meant that the card in question was correctly placed with respect to the card immediately preceding it. Any other placement was considered incorrect. For example, if the subject placed card #7 in the original order directly after card #6, this placement was designated as correct if the subject gave up a token; any other location was designated as incorrect. The no-feedback subjects were not given any assistance.

The use of a subject determined feedback option dealt with problems in timing. If feedback is given too soon or is too readily accessible, the error rate may increase (Sullivan, Schutz, & Baker, 1967). Our pilot studies confirmed this: in the text synthesis situation, providing subjects with as much feedback as necessary resulted in the subjects simply making a move and awaiting confirmation. While the research allowing subjects to control feedback has not been conclusive (Anderson, Kulhavy, & Andre, 1971; Melching, 1966), this approach appeared to be more suitable to our needs, especially regarding the subject's estimate of when concordance had been achieved, and the subsequent impact on achievement.

The use of five tokens was an arbitrary decision. As noted, a 100 percent feedback model led to a passive subject performance. On the other hand, we could not preassign percentages of feedback since the reconstructed process was defined in part by the number of moves, which was highly individualized. A move was defined as a change in the relative position of a card to one or more other cards, once the card had been placed.

Following the practice task, each subject was given one of two scrambled packets of cards. The feedback subjects received five tokens once more, while the no-feedback subjects again reconstructed a passage without assistance. The subjects signalled when complete. Immediately after the cards had been ordered, written recall and recognition tests were given, in that order. For the free recall task, the subjects were asked to "write down as many sentences as possible; they need not be verbatim or in any special order." For the recognition task, the subjects were given a test consisting of 26 pairs of sentences. Within each randomly ordered pair, one sentence was an original while the other was a paraphrase. The paraphrase did not change the meaning of the original sentence. The subjects were asked to choose the original sentences.

The independent variables were passage (P), feedback (FB), and immediate-delayed (DL). The dependent variables were percent recall scores (RL), percent recognition scores (RG), concordance (TA), time in minutes to order the passage (TM), number of moves (MV), and number of tokens used in the feedback conditions (TK).

The starting and stopping times were recorded to give a measure of time for all processing (including feedback procedures), and the number of tokens used was also recorded. In addition, while a subject wrote the recall test, the experimenter recorded the sentence order in which the subject had placed

the cards. Kendall's Tau, computed for each subject's final order was used to obtain a measure of concordance with the original text order.

Analysis

Percentage recall scores were derived by establishing the number of idea units within each passage. Following the work of Bovair and Kieras (1982), the Fermi passage was broken down into 95 idea units, and Nixon 90. The conceptual densities of the two passages were quite similar.

ANOVA of recall scores with passage (P), feedback (FB), and immediate-delayed (DL) as independent variables yielded no statistically significant effects. Although statistically non-significant, the Fermi means (15.08) were higher than Nixon (12.96).

ANOVA for percentage recognition scores is given in Table 1. The statistically significant finding is for passage (P), $F(1,40)=42.72$, $p<.001$.

Insert Table 1 about here

The passage means and standard deviations are given in Table 2. The Nixon means (85.04) are almost 20 percentage points higher than for the Fermi passage (65.13).

Insert Table 2 about here

The contribution of concordance (TA) to retrieval has been a major problem in our research. ANOVA yielded a statistically significant finding for feedback, $F(1,40)=6.22$, $p<.02$. The results are given in Table 3. Consistent with our findings throughout there were no interaction effects. The means and standard deviations for tau are given in Table 4.

Insert Tables 3 and 4 about here

The mean tau for feedback was .47, and .27 for no-feedback. The simple Pearson r between tau and recognition was -.27, $p<.05$. The presence of a significant negative correlation is not readily amenable to explanation at present. The r between tau and recall (.04) was not statistically significant.

We decided to analyze concordance further, employing a more qualitative procedure (Langer & Keenan, 1984). Arbitrarily we divided the passages into two units, consisting of sentences 1-13 and 14-26 in the original order. The maximum occurrence of the first 13 sentences in the first 13 slots without respect for order is 156 (13 sentences x 12 subjects). The results are of course identical for the second half since deletions among the first 13 sentences become insertions within sentences 14-26, and vice versa. For the Fermi article the feedback-no feedback proportions were 111/156 (71 percent) and 83/156 (53 percent), while the Nixon proportions were 101/156 (65 percent) and 91/156 (58 percent) for the feedback-no feedback conditions. While the Nixon feedback-no feedback differences were only marginally different, concordance was improved with feedback for both passages.

There were some common sequence patterns within each passage. For the Nixon article, Sentence #1 in the original order was not only first on all 12 of the feedback group, but also nine of 12 in the no-feedback group. Indeed, a sequence consisting of Sentences #1, #2, and #19 in the original text occupies the first three positions for seven out of 12 no-feedback subjects, but only two of the 12 feedback subjects. In this instance feedback seemed to hinder commonalities in ordering.

For the Fermi passage we find the exact sequencing of Sentences 1 - 7 appearing in 4 of the 12 feedback subject protocols, but none of the no-feedback group. In fact, Sentence #1 appears first in 7 of the 12 feedback protocols, and only 2 of the no-feedback group. Unlike the Nixon passage, feedback provided some commonalities within the feedback group.

ANOVA for time to completion yielded a positive effect for feedback $F(1,40)=6.35$, $p<.02$. The respective means for feedback and no-feedback were 27.92 and 21.69 minutes respectively. As expected, feedback took more time.

The use of tokens also followed predictable lines. ANOVA yielded strong main effects for content ($F(1,40)=7.62$, $p<.01$) and feedback ($F(1,40)=145.34$), $p<.001$). The latter, of course, is an artifact of the analysis. Possibly because the Fermi article was less familiar, subjects used an average of 4.25 tokens across the feedback conditions, while the Nixon subjects used an average of 2.67 tokens. Correspondingly of the 12 Fermi subjects in the feedback condition, eight (67 percent) used the maximum of five tokens. For the Nixon article only two subjects (16.7) used a maximum of five tokens.

There was also a significant interaction between passage and feedback ($F(1,40)=7.62$, $p<.01$). The Fermi subjects used an average of 4.67 and 4.17 tokens across the immediate and delayed conditions, while the respective Nixon totals were 2.33 and 3.0.

Finally, after the experiment the subjects were asked when the event had taken place, and what the passage was about. The median date assigned among the Fermi feedback subjects was 1943, and 1945 for the no-feedback. (The actual date of the events described was 1942.) For the Nixon article, both the feedback and no-feedback group assigned a median date between 1972-1973. The date of the tape was impossible to establish, but clearly the Nixon event was contemporary, since the spread of dates was considerably

less than for the Fermi article. All groups accurately described the content of the passages.

Discussion

Over a decade ago, Clark (1973) warned about the treatment of content as a fixed-effect. Our work in the area of feedback clearly supports this assumption. In an attempt to get away from artificially structured text, and to investigate the effects of feedback on reconstruction, we have uncovered a whole new set of variables. Frankly, at this moment we are not too certain just how feedback does operate within the associative network. There are several problem areas which have to be resolved. These include individual needs for feedback, and selectivity in information processed as a result of the task demands and feedback available.

That the utilization of feedback is more individualized than previously suspected is obvious from differences in our findings when even relatively minor content changes are made (Langer & Keenan, 1984; Keenan, Langer, & Medosch-Schonbeck, 1985). The idiosyncratic usage of feedback can be observed in other ways. For example, the subjects used the tokens available in a variety of strategies. Some preferred to make requests throughout the reconstruction process, while others waited till they felt that the sequence was appropriate, and then used the tokens to confirm their logic. The latter was much more of a gamble, since disconfirmation meant the operating hypotheses were wrong. Subjects expressed a strong sense of disappointment under these conditions.

Second, while reconstructing the discourse, the constant scanning of individual sentences seems to assist recognition retrieval, especially for familiar materials. This behavior may preclude any significant propositional elaboration; instead subjects use the individual sentences to form some type of loose organization based on local coherence and context,

which assists in the formulation of rote episodic memory (Tulving, 1972; Tulving & Thomson, 1973). Our protocol analyses would support the idea of a loose clustering of ideas which do not establish differences in recall (i.e., gist) among the groups, regardless of familiarity. Achievement outcomes assisted by feedback may be more situation-specific than formerly believed. Depending on the task, the feedback available may assist one type of retrieval (e.g., recognition) at the expense of another (e.g., recall).

If the argument is raised that we are using a limited confirmation-disconfirmation paradigm as our feedback stratagem, we can argue that no one knows how much and what kinds of information would make any difference at all, although one can speculate it might (Getsie, Langer, & Glass, 1985). Certainly confirmation-disconfirmation is a minimal feedback procedure (Gelman, 1969; Anderson & Faust, 1973), but this was our intent from the onset.

Instructionally, these findings represent a more critical dilemma. We can only speculate, but as learning proceeds, and the accompanying propositional networks (or schemata) are modified, then feedback utilization may change. Kulhavy and Parsons (1971) suggest that the effect of feedback is minimal unless the content is organized in some way meaningful to the learners. Our research suggests that the interaction is symmetrical; at some point meaningfulness changes feedback needs.

Research on these variables and others is continuing, but we would suggest a modicum of caution in following the general guidelines used in preparing feedback for instructional purposes.

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Appendix A

Fermi Passage

1. Herbert Anderson and his group at the Met. Lab had been building small piles and gathering information for a larger pile.
2. The best place they had been able to find for work on the pile was a squash court under the West Stands of Stagg Field, the University stadium.
3. President Hutchins had banned football from the Chicago campus and Stagg Field was used for odd purposes.
4. On Ellis Avenue, through a heavy portal, is the entrance to the space beneath the West Stands.
5. The squash court, which was part of this space, was 30 feet wide, twice as long, and over 26 feet high.
6. The physicists would have liked more space, but places better suited for the pile had been requisitioned by the expanding armed forces stationed in Chicago.
7. The physicists were to be contented with the squash court, and there Herbert Anderson had started assembling piles.
8. They were still "small piles," because material flowed to the West Stands at a very slow, if steady, pace.
9. As each new shipment of crates arrived, Herbert's spirits rose.
10. He loved working and was of impatient temperament.
11. His slender, almost delicate, body had unsuspected resilience and endurance.
12. He could work at all hours and drive his associates to work along with his same intensity and enthusiasm.
13. A shipment of crates arrived at the West Stands on a Saturday afternoon when the hired men who normally unpack them were not working.

14. A university professor, older by several years than Herbert, gave a look at the crates and said lightly, "Those fellows will unpack them Monday morning."
15. "Those fellows, Hell! We'll do them now", flared up Herbert, who had never felt inhibited in the presence of older men, higher up in the academic hierarchy.
16. The professor took off his coat, and the two men started wrenching at the crates.
17. Profanity was freely used at the Met. Lab -- it relieved the tension built up by having to work against time.
18. Would Germany get atomic weapons before the United States developed them?
19. Would these weapons come in time to help win the war?
20. These unanswered questions constantly present in the minds of the leaders of the project pressed them to work faster and faster, to be tense, and to swear.
21. Success was assured by the spring when a small pile assembled in the squash court showed that all conditions were such that a pile of critical size would chain-react.
22. "It could be May or early June," Enrico told me, "I remember I talked about that experiment on the Indiana dunes."
23. "After a swim in the lake, we walked along the beach and I talked about the experiment with Professor Stearns."
24. "The two of us walked ahead on the beach to speak in such a way that the others would not understand."
25. "Why? Didn't everyone at the Met. Lab know that you were building piles?"

26. "They knew we built piles, but they did not know that at last we had the certainty that a pile would work and a chain reaction was feasible."

Appendix B

Nixon Passage

1. On Tuesday afternoon, July 9, Rodino shattered the President's show of business as usual.
2. He released the Judiciary Committee's version of eight tapes.
3. There were awesome differences between what the White House had managed to transcribe and what the committee staff, using superior equipment, was able to hear on the same recordings.
4. To Rodino, the differences demonstrated that the cover-up was still in progress, with the concurrence of Haig and of Nixon's lawyers.
5. The staff had prepared a 131-page side-by-side comparison of the texts.
6. Nearly a hundred major discrepancies and omissions were noted.
7. The White House editing proved to be predictable.
8. Changes seemed tailored for St. Clair's claim that the President knew nothing of the cover-up until March 21, 1973 and then had acted to end it.
9. According to the White House version of the meeting of March 22, 1973, the President told his aides that John Mitchell was recommending "that now we use flexibility in order to get off the cover-up line".
10. The committee transcript said that Nixon quoted Mitchell to the opposite effect, that "we use flexibility .... in order to get on with the cover-up".
11. Nixon's order that day to Mitchell, which Haig, St. Clair and Buzhardt had tried to hide from the committee, was also there.
12. "I don't give a shit what happens."
13. "I want you all to sontewall it."
14. "Let them plead the Fifth Amendment, cover up or anything else if it'll save it."

15. "Save the plan."
16. "That's the whole point."
17. St. Clair tried to justify the omissions and discrepancies.
18. That section had been left out, because it was not deemed relevant, he told reporters.
19. It concerned the Senate Watergate Committee.
20. Technically it did not involve an obstruction of justice, since it referred to a congressional, not a Justice Department, investigation.
21. The subpoena had called for a conversation among Nixon, Dean and Mitchell.
22. The omitted conversation occurred after Dean had apparently left the room.
23. It was therefore outside the bounds of the subpoena, St. Clair said.
24. "What about the other discrepancies?", the reporters asked.
25. "I would not look upon this as sinister."
26. "My experience has been that if you give these tapes to three people to listen to, you get three variations."

Table 1

ANOVA: Percentage recognition scores.

Source	SS	Df	MS	F	Sig
Mean Effects	4741.73	3	1580.58	15.63	.001
NS	1692.19	1	1692.19	16.73	.001
FB	1716.02	1	1716.02	16.97	.001
DL	1333.52	1	1333.52	13.19	.001
2-way Interaction	680.73	3	226.91	2.24	.10
NSxFB	99.19	1	99.19	.98	.33
NSxDL	438.02	1	438.02	4.33	.04
FBxDL	143.52	1	143.52	1.42	.24
3-way Interaction	438.02	1	438.02	4.33	.04
NSxFBxDL	438.02	1	438.02	4.33	.04
Explained	5860.48	7	837.21	8.28	.001
Residual	4045.50	40	101.14		
Total	9905.98	47	210.77		

Table 2

Percentage recognition scores: Mean and standard deviations.

Condition	Variable	Mean	SD
NS	13-sentence	76.08	13.04
	26-sentence	64.20	13.68
FB	Feedback	76.13	12.92
	No-feedback	64.17	13.75
DL	Immediate	75.42	11.96
	Delayed	64.88	15.15

Table 3

ANOVA: Tau

Source	SS	Df	MS	F	Sig
Mean Effects	.71	3	.24	2.20	.10
NS	.06	1	.06	.56	.46
FB	.54	1	.54	5.04	.03
DL	.11	1	.11	.99	.33
2-way Interaction	.36	3	.12	1.11	.36
NSxFB	.08	1	.08	.75	.39
NSxDL	.17	1	.17	1.55	.22
FBxDL	.11	1	.11	1.03	.32
3-way Interaction	.04	1	.04	.34	.56
NSxFBxDL	.04	1	.04	.34	.56
Explained	1.10	7	.16	1.47	.21
Residual	4.28	40	.11		
Total	5.38	47	.12		

Table 4

Tau: Mean scores and standard deviations.

Condition	Variable	Mean	SD
NS	13-sentence	.48	.38
	26-sentence	.41	.30
FB	Feedback	.55	.34
	No-feedback	.34	.31
DL	Immediate	.40	.31
	Delayed	.49	.37