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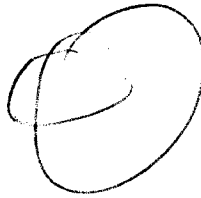
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Designing learnable texts

The effectiveness of revisions based on a text processing model

Keywords: learning, text design, text comprehension, text revision

Revising texts to improve learning has produced successful revisions but the reasons why they were successful has not been made clear. In this review, we describe the text revision strategy derived from the text processing model of Kintsch by Britton and Gülgöz (1991). Three principles were developed and implemented on natural texts to make them more memorable. The texts used in different experiments varied in content and language and the studies employed different measures of learning and reading time. The emerging pattern from the reviewed studies is that revised texts that add the missing connections to the text, lead to better learning, especially when readers lack inference-making skills, domain-specific knowledge or motivation for cognitive effort.

Many studies dealing with text revision accept that, besides reader characteristics and the cognitive processes involved in decoding and storing text information, text characteristics are also very influential in determining the degree of learning from that text. Evidence showing the importance of text structure accumulated and some studies were able to show the sustained effect of text structure despite variations in the interest level of the text or the text topic. Some studies degraded already existing texts and were successful in providing evidence for the impact of text structure. For example, Wenger and Spyridakis (1993) removed coherence cues from

the text and observed that performance in recall, recognition, and problem solving tasks suffered. However, interpretation of the effects of cohesion becomes rather difficult in degraded texts because qualities of the natural text other than the desired ones may have been eroded with the omission of components that support cohesion in the texts.

Other text researchers assumed that texts could be written in ways that can improve learning and retention. This could be regarded as cognitive ergonomics in one sense: the text researchers were trying to design texts that were more compatible with the human cognitive system. The design required the texts to allow smoother and easier processing.

These revision studies not only focused on adding new components to the text but also considered the processing of the text itself. Therefore, the revisions focused on other modifications that were guided by research results and processing models instead of adding components such as headings, subheadings, advance organizers, summaries, and questions that afforded ease of processing and increased the opportunities for learning. For example, Britton, Gülgöz, and Glynn (1993) reviewed 23 revision studies in which naturally occurring texts were revised using different techniques. One of the techniques included in these studies was reorganizing the different parts of the text. The ideas were reorganized by the researcher so that the sequence of ideas was more logical, more compatible with the purpose of the text, or they followed a sequence that the researcher thought was more reasonable for a learner to follow. Another technique was to make explicit the main ideas that were implicit

in the text. Thus, the researchers believed, the reader would not miss the main points of the text, which would also facilitate learning of the rest of the text. Other techniques included adding signaling devices that explicated the structure of the text content, incorporating preview sentences that directed the reader to the intended meaning, changing or removing certain details or examples, and adding connectives and other structural information. In general, these studies did not systematically use one or more of these techniques. Rather, they made all possible changes that they deemed necessary and useful. Out of the 23 studies, 20 showed better learning from revised versions of the texts.

With these studies, it was rather difficult to distinguish those changes that resulted in improvement from those that did not. In an attempt to single out those revisions that did lead to improvements in text, Gülgöz (1986) used twelve passages that Graves and Hodge (1943) revised for better comprehension. Graves and Hodge (1943) had taken passages from various fields and authors and revised them according to a set of rules. They specified for each text revision, what type of modification they had done and the justification for that modification. The revisions of the twelve texts included different numbers of various modifications. Each modification corresponded to a component in the text that Graves and Hodge (1943) had identified as a potential cause for difficulty of comprehension. From an empirical standpoint, the first question that needed answering was whether the revised versions were indeed more comprehensible and consequently memorable. Gülgöz (1986) gave the twelve passages to undergraduate students for recall. The participants received an equal number of original and revised passages with no particular order. The results of the study indicated an overall advantage for the revised versions of the passages. For most passages, the revised versions were recalled better than the original passages. The next issue was to determine those modifications that were essentially influential for the improvement in recall. For this, the improvements in recall were correlated with the changes that were made for that passage. The resulting coefficients showed no correspondence between the changes made and

the improvements in recall. Britton, Van Dusen, Gülgöz, and Glynn (1989) reported two more studies on recall of information from texts rewritten by experts. In one study, passages from army training manuals were used. Experts rewrote these passages in order to achieve better learning, and explanations were given for the changes they made. The goals of this study were similar to that of Gülgöz (1986): to empirically show that the revisions really did improve learning from texts and to identify those modifications that led to better learning. The results were also similar to those reported in Gülgöz (1986). Only some of the passages showed an advantage for revised versions and the improvements could not be accounted for by the modifications reported by the experts who rewrote the texts. In another study, Britton et al. (1989) investigated the recall of different revisions of two history passages. Graves and Slater (1986) gave these passages to three different groups of experts for revision. These groups of experts were college composition instructors, discourse researchers, and Time-Life editors. There were two original passages and three revisions for each. Britton et al. (1989) conducted a study to test for the recall of these passages and observed that while the revisions by college composition instructors were better recalled by the participants, those revisions prepared by Time-Life editors and discourse researchers did not have any influence on recall. However, even with the texts that improved recall, which were rewritten by college composition instructors, there were no explicit strategies that could be identified as the cause of improvement in learning.

The major finding in the studies reported so far is that even though many revisers are able to improve texts for better learning at least some of the time, the revision strategies are based on reasoning and the implicit theories of the revisers about learning from text. There was no indication in any of the studies that some form of explicit, declared formula was instrumental in improving learning from text. Moreover, those modifications that were declared by the revisers did not correspond to the improvements in learning or they did not lead to better learning from all texts in a consistent manner. It is likely that successful revisions were

the result of procedural knowledge that the revisers were able to use but could not declare. Their declared modifications were not necessarily what led to improvements.

Cognitive models as guides for revision

The revision strategies devised in the studies discussed so far were products of reasoning, common sense, and teachings of journalism and composition. There was very little involvement, if any, of theories regarding the cognitive processes underlying the reading comprehension and learning processes in these studies. However, cognitive models of reading provide a perspective for the evaluation of text in which the comprehension and learning of the reader is the only criterion. Concepts like elegance of wording, the sound of the prose, vividness of detail, and the ability to capture the reader become obsolete from this perspective as long as the aim is learning of information from the text. The only valid concern that remains is whether the text in a particular form is compatible with the processes that comprise the function of learning from text, and whether the text structure facilitates learning for the reader. If the text is written with the purpose of communicating new information to the reader with the intention that the reader will retain this information, the text must serve that very purpose. Otherwise, it has no value even if it is elegant, gripping, compelling and skillfully written. Models of reading may serve the purpose of evaluating a text by predicting the ease of processing the text according to that particular theory. The ability of the model to predict the text comprehension levels would be one of the measures of how well the model reflects the actual mechanism. Text comprehension models may also serve as tools to revise texts in order to facilitate learning by the reader. The texts can be customized to take advantage of the processes involved in learning as the model specifies.

Beck, McKeown, Sinatra, and Loxterman (1991) created revisions of a history text on the basis of models of reading and information processing. They used several operations like clarifying, elaborating, explaining and providing motiva-

tion for actions, and making explicit the connections between different parts of the text. They gave the original or the revised version of the text to 4th and 5th grade students and after reading the passage, the participants recalled the information in the text and answered questions about it. The readers performed better both on the recall task and the questions if they had read the revised version. Beck et al. (1991) used the more generic reading model of information processing. In a similar study, Britton and Gülgöz (1991) used the Kintsch and Van Dijk (1978) model of text processing to revise texts. In using this model and its offshoots, they aimed to develop a set of principles to revise texts for better learning. In order to do justice to the principles employed in text revision, it is necessary to explain the Kintsch model briefly.

Kintsch model of text processing

In the Construction-Integration model, Kintsch (1988, 1994) distinguished between two levels of representation of the text in the episodic memory: textbase representation and the situation model. At the textbase level, the representation consists only of the components of the text and the relationships among them that can be derived directly from the text, without any reference to the prior knowledge of the reader. This can be a representation that is not necessarily fully connected or coherent. In order to achieve coherence, the reader must use his or her prior knowledge and make the necessary inferences. The situation model is the representation achieved when the information from the text is integrated with the prior knowledge about the content of the text and other knowledge sources — about the language, the world, the particular situation, personal experiences (Kintsch, 1998).

The Construction-Integration model is a result of the evolution of the earlier Kintsch and van Dijk (1978) model of text processing. The earlier model dealt with the representation of text in the working memory and long-term memory in a way that could be considered the textbase representation

in the recent Construction–Integration model. In the Kintsch and van Dijk model (1978), chunks of text input to the working memory were first attempted to be connected to existing information in the working memory that was carried over from a previous cycle of processing. This enabled the particular portion of text to be connected among its various parts as well as to the information that was held in working memory. Later, the new portion of text, now with connections among its parts, was connected to the representation of the whole text. In the early versions of the Kintsch model, the connections between different parts of the text were achieved by argument overlap. In other words, the concepts that act as the agents or the objects of actions are repeated in different parts of the text and these repeated concepts provide a means for connection between these parts. For example, in the text:

- (1) A neuron has three parts: dendrites, cell body, and axon.
- (2) The dendrites look like the branches of a tree.

The second sentence is connected to the first by the word ‘dendrites’ which is the only repeating argument in both sentences. According to this model, the processing system will search for a repeating argument until it finds one in order to connect the new information to the existing representation. When the reader cannot find an appropriate overlap that affords connection, there is a need to make an inference. Making an inference is adding information to the text representation from long-term memory so that implicit relationships between various parts of the text are made explicit.

Miller and Kintsch (1980) had provided a simulation program for this model. The text, in the form of propositions, was entered into the simulation and the output contained the connections that a reader would make between these propositions. The simulation program lacked the capacity to make inferences and therefore whenever it encountered a difficulty in making connections, the processing stopped. The proposition or propositions that represented the inference required for making the connection was then

added to the proposition list. This time, the simulation continued and the connections were possible with the aid of the added propositions. In a way, the simulation program functioned as a diagnostic tool to identify those areas of the text which were not easily linked to the rest of the text. The identification of such areas would determine the inferences required from the reader. The final output of the simulation program was the description of the hierarchy of connections between different parts of the text. This description included a listing of which propositions were connected to each other. This provided for an evaluation of whether desired connections were assured by the text.

Importance of connections between ideas

Britton and Gülgöz (1991) employed the Miller and Kintsch (1980) simulation program to determine the location in the text where inferences were required and to evaluate the connections that were supported by the text. They assumed that a reader with insufficient knowledge would be behaving in the same fashion as the simulation program did, with a minor difference. Like the simulation program, the reader who lacked the prior knowledge necessary to make the inference would not be able to connect the text to the existing representation. However, unlike the simulation program, the reader would continue with a text representation that contains a gap where an inference should be. Apart from prior knowledge, there are other conditions necessary to make the inferences that would close the gaps in the text. First, the reader must be monitoring the comprehension process so that when an idea is encountered in the text and it cannot be connected to the representation, the reader will notice that a gap exists. If the reader notices the gap, he or she may be in the habit of accepting such disconnected representations or may decide to expend the additional effort to find a connection. If the reader decides to close the gap, there is a need to search for the connection in the representation of earlier text and the representation of the domain-specific prior knowledge. If the reader can find the particular

information that will enable the connection, then the working memory capacity must enable the addition of extra processing. Finally, the reader must use that information to make the connection if his/her inference-making skills are developed enough. Britton, Stimson, Stennett, and Gülgöz (1998) were able to support an individual differences model for learning from instructional text. Whether a reader will make the connections in the text was observed to be dependent upon four variables: metacognition, inference-making ability, working memory capacity, and domain-specific knowledge.

The assumption of Britton and Gülgöz (1991) was that most readers would lack one or more of the skills necessary to make the inferences or they will not be motivated to expend the extra cognitive effort unless the cost of not making the inference was too high. Thus, to increase the chances of fully connected representations the text could be revised to contain all the connecting information, alleviating the demand on the readers to make those inferences. Quite arguably, the readers would be more likely to develop a situation model of the text if they make the inferences themselves and make the connections with their already existing representations relevant to the text. Kintsch and his colleagues (Kintsch, 1988; 1994; McNamara & Kintsch, 1996; McNamara, Kintsch, Songer, & Kintsch, 1996) have frequently pointed to that as a disadvantage of fully connected (explicit) texts. However, we believe that only a small minority of readers would benefit from a text with gaps in it because of all the skills required to perform the inferences in the text and because most readers would submit to the principle of least effort (Zipf, 1949) even if they possess the necessary skills.

Our argument is congruent with the minimalist hypothesis (McKoon & Ratcliff, 1992) in essence, although we limit our claim to expository texts. In narrative texts, there is evidence that readers generate causal inferences but not elaborative inferences automatically (Millis & Graesser, 1994). Noordman, Vonk, and Kempf (1992) argue that readers do not make causal bridging inferences while reading expository texts unless the particular task or the text cues

force them to do so. On this basis, we argue here, just as Britton and Gülgöz (1991) did, that a connected text would serve the more critical function of learning the content of the text by increasing the probability that the reader would form a connected representation of the text.

The simulation of text processing presented another crucial piece of information: how a text would be connected. For an adequate representation of the text, it is not sufficient that the connections are made, it is also necessary that the connections must be those intended by the author. The simulation program showed which parts of the text were connected enabling an evaluation of whether these connections were the intended ones. Inserting the connections in the text and not leaving these connections up to the reader increased the probability that readers would form the text representations with the intended connections.

Text revision process

In the Britton and Gülgöz (1991) study, the simulation program was used to analyze the text and then to make systematic revisions so that the text was fully connected at the end and the connections were made between the intended units of information in the text. One important aspect of this revision process was that it was systematic, meaning that the changes in the text were not arbitrary. There were three principles in revising the text. These principles, when applied routinely and consistently, satisfied the purpose of the revision to achieve a fully connected text with the right connections.

The Britton and Gülgöz (1991) study used the three major principles to revise a history text explaining one part of the Vietnam War. The principles were instrumental in satisfying the demands of the simulation program when consistently applied and they were also in agreement with the Kintsch model as well as previous research findings. In order to explain how principles were applied and to give a sense of the text used in the study, we give examples from the Vietnam War text.

Principle 1 stated that each sentence should be rewritten so that the word linking the two sentences is repeated. The rationale for this principle was the basic processing mechanism in the model, that is, argument overlap. For argument overlap to occur, repetition of the same concept is necessary. This allows the reader to determine and identify the connection point in the text. It is also important that the repeated term is not just any word but the one that is desirable for the connection. Sentences (3) and (4) are examples of two sentences that cannot be connected.

- (3) By the fall of 1964, Americans in both Saigon and Washington had begun to focus on Hanoi as the source of the *continuing problem in the South*.
- (4) As frustrations mounted over the *inability of the ARVN to defeat the enemy in the field*, pressure to strike directly at North Vietnam began to build.

As there are no repeated arguments in sentence (4) from sentence (3), it is necessary to make an inference. It is evident that the required inferences are more than just a connection between the two sentences. First, as the focus of the passage is on the continuing war and that is stated as the continuing problem in sentence (3) and as the inability of the ARVN in sentence (4), there is a need to make the connection between them explicit. Additionally, even though the protagonists in both sentences are the same, the connections between them cannot be made because they are referred to with different terms in these sentences. For example, the frustrations mentioned in (4) belong to the Americans in (3) and the reference to North Vietnam is made as Hanoi, the capital city, in (3) and as the enemy in (4). Also in (4), ARVN indicates the army of South Vietnam and in (3) a reference is made to the South Vietnam with “the south.” For a naive reader, all these references are unrelated and inferences to connect them are virtually impossible even though for a very knowledgeable reader, they may be quite obvious. In order to eliminate this type of confusion from texts, they also used a corollary to Principle 1. This corollary was that the same term was to be used every time the same concept was referred to. This was simply to assure argument overlap in

cases where the readers did not know that two terms referred to the identical referent. When Principle 1 and its corollary were applied to sentences (3) and (4), the result was similar to (5) and (6). However, there were other modifications to these sentences on the basis of other principles. Therefore, they do not reflect the final form used in the revised text.

- (5) By the fall of 1964, Americans in both South Vietnam and Washington had begun to focus on North Vietnam as the source of the *continuing war in the South*.
- (6) As frustrations of the Americans mounted over the *inability of the ARVN to win the war against North Vietnam*, pressure to strike directly at North Vietnam began to build.

Principle 2 stated that one should arrange sentences such that the first part specifies the information in the mental representation that new information will be connected to, while the second part gives the new information. In a sentence, the familiar information has the function of establishing the connection between the information in the mental representation and the new information. If the unfamiliar, new information is presented first, the reader will not be aware of the connections available between this new information and those already in the representation. By the time the reader encounters the familiar information, a number of inappropriate connections may be made or information may be lost because it exceeded the limitations of the working memory. Therefore, the second principle assures that the part of text that is instrumental in making the connection with the representation forms the first part of the sentence, to be followed by the new information. The implementation of this principle can be seen in sentence (7), which is the modified version of sentence (4) according to Principle 2.

- (7) The *inability of the ARVN to defeat the enemy in the field* caused frustrations and pressure to strike directly at North Vietnam began to build.

The last principle, Principle 3, was straightforward, and stated that one should make explicit any implicit references.

Applying this principle to sentence (7) gives us sentence (8).

- (8) The inability of the ARVN to defeat the enemy in the field caused frustrations among American officials and pressure to strike directly at North Vietnam began to build.

Sentence (7) contained an implicit reference about the frustrations and the pressure regarding who experienced them. In order to make the correct connections, it is important to identify the agent in the sentence. For example, it is important that the frustrations are not attributed to the South Vietnamese army. Therefore, Principle 3 secures the correct referent by making implicit references explicit.

Implementations of the principles and learning

As we indicated before, the ultimate purpose of devising any revision algorithms is to improve learning from text. Such revision studies function as indirect but powerful tests of explanatory models as well. The studies described below were not conducted with the purpose of devising a method to improve texts. The aim of these studies was to investigate the relationship between text structure, reader characteristics such as knowledge and cognitive motivation, and learning from text. They did, however, use texts that were revised according to the principles derived from the Kintsch model. Therefore, in our review of these studies, we will only focus on the findings relevant to text revision using these principles. In all studies reported here, main effects of other variables or the interaction of these variables with text structure or both were observed. However, we will restrict ourselves to a review of the effect of text revision here in an effort to observe a general trend.

Britton and Gülgöz (1991) study

Britton and Gülgöz (1991) investigated the influence of such revisions in two experiments. In one of the experiments, there were two other versions of the text in addition to the

original text and the version revised according to the principles explained above. They were the readability version and the heuristic version. The readability version was the original text recreated by shortening sentences and replacing long and complicated words with simpler and shorter synonyms. The heuristic version was created by one of the authors (B.K. Britton) on the basis of his judgment of what comprehensible text should be like in addition to his knowledge of the Kintsch model. These two versions will not be discussed any further here because the readability version did not lead to any improvements in learning and the changes in the heuristic version could not be identified clearly although they did lead to some improvement in learning.

In the first experiment of the Britton and Gülgöz (1991) study, the readers were undergraduate students who read the original text or the version of the text revised according to the principles (hereafter referred to as the revised version). After reading the text, they were given a free recall task and a multiple-choice test that contained both factual and inference items. The amount of time readers spent reading the text was also recorded. The results showed the revised version to be superior. It was recalled better than the original text; it enabled more efficient learning such that recall as a proportion of the time spent reading was higher; and in the multiple choice items dealing with the inferences, readers of the revised version performed better. There was no difference in factual multiple choice questions but this is not unusual because these were recognition items that did not require any connection or link for retrieval. The presence of links or connections becomes critical in tasks like the free recall task where the readers are instructed to write down whatever they remember from the text. In the case of free recall, the reader needs to generate the retrieval cues and the retrieval of some information would act as a cue for other information. For retrieved information to act as cues for other information, the representation needs to be connected. The evidence supports the argument that the provision of connections in the text leads to a connected text more often than a text with gaps. Further support that readers frequently fail to make such inferences themselves was seen in the

results of the multiple-choice questions on the inferences. Kintsch and McNamara (Kintsch, 1994; McNamara & Kintsch, 1996) argue that such results may be due to the knowledge level of the readers in this experiment. With readers who had extensive knowledge about the Vietnam War, the results may have been reversed. They obtained some support for their argument in a series of experiments (McNamara & Kintsch, 1996; McNamara, Kintsch, Songer, & Kintsch, 1996).

In the second experiment of the Britton and Gülgöz (1991) study, the readers were army recruits who were the actual audience of the text used in the experiments. The readers were given either the original or the revised version of the Vietnam War text and then the cognitive structure test. The cognitive structure test is designed to derive a description of the mental representation of the text by giving the readers pairs of critical concepts from the text and asking them to indicate the degree to which each pair of concepts is related to each other. This procedure results in a multi-dimensional depiction of concepts and their relationships. The comparison of a reader's representation with that of an expert or, even better, with the author allows a measure of learning by the reader. The results of the cognitive structure test were used to compare the readers of the Vietnam War passage with the mental representations of the author and several experts. This comparison indicated that readers of the revised version had learned better than the readers of the original text.

McNamara and Kintsch (1996) study

McNamara and Kintsch (1996) set out to test their argument that readers with sufficient domain-specific knowledge would not benefit from the connected (explicit) text. Instead, they would learn better with the version containing gaps because that text would compel them to make connections between the text information and the information in their long-term memory. They used the original and the revised versions of the Vietnam War passage in Britton and Gülgöz (1991). In order to create a high-knowledge group they

provided pre-training to some of the participants. Unfortunately, this turned out not to be a successful manipulation though some of their findings are relevant here. They found that the reading speed for the revised version was higher. The recall performance showed only a marginal advantage for the revised version. The results of the sorting task which was designed to measure the formation of the situation model indicated that the readers with little prior knowledge performed better if they read the connected version. Finally, readers of the revised version had higher accuracy on the multiple-choice questions. These results strengthen those obtained by Britton and Gülgöz (1991) but also add a dimension that was not discussed before, that is, the formation of a situation model. All the arguments so far concerned the formation of the textbase representation and did not mention formation of the situation model because that is a more sophisticated level of processing for which the reader needs to integrate the text information with the existing information in the long-term memory. McNamara and Kintsch (1996) were able to demonstrate that readers who had little prior knowledge about the Vietnam War were still able to develop some form of a situation model when they read the revised version of the text. Even if the highly knowledgeable readers benefited more from the original text in the sorting task, the audience of the text did not consist of such readers and neither do the audiences for most instructional texts. Moreover, the method of measuring learning seems to be sensitive to text structure and therefore, multiple measures need to be employed by researchers to verify such a differentiation between readers of various levels of knowledge in their preference for connected or disconnected text. The need for consistency and identification of trends in results of research that were conducted using multiple measures of learning is the motivation in the current work.

More recent research

Here, we will review results from studies conducted by Gülgöz and his colleagues with the purpose of analyzing the relationship between text structure and other variables. We

will exclude the results related to other variables for the sake of brevity and because they are the topic of discussion elsewhere. Our focus here will be on the effects of modifications implemented using the principles derived from the Kintsch model. With the exception of one study, the principles were applied to different texts in Turkish. We find the results significant for that reason as well; they show some generality across texts and across languages.

In an endeavor to test whether knowledge and text structure had similar results in a sample of readers who read a text in a foreign language, Turkish readers, who learned English as a second language and who attended a university where the medium of instruction was English, were given the Vietnam War text or its revision to read (Gülgöz & Odabasi, 1998). Half of the subjects in each group were subjected to a pre-training on the Vietnam War before they read the text. The pre-training to create a high-knowledge group was not a successful manipulation in this experiment either. Learning from text was measured by the multiple-choice test containing the inference items and the cognitive structure test. The readers of the revised version performed better on the multiple-choice test but there was not a significant difference in the cognitive structure test although the direction of the results was as predicted.

In another study (Gülgöz, Kumkale, & Aktunç, 1998), the effects of knowledge and other texts read prior to the target text were investigated using a text in Turkish about neural transmission. The participants of the study were all native speakers of Turkish. The original text was taken from an introductory psychology textbook and the principles derived from the Kintsch model were used to revise the text. The readers were given either the original text or the revised version to read followed by a free recall test and a comprehension test. The comprehension test was composed of open-ended questions designed to measure the degree to which the readers formed a situation model, combining the text information with their prior knowledge. The results showed that the readers of the revised version recalled more information and they also outperformed the readers of the original text in the comprehension test. Significant differ-

ences in both the recall task and the comprehension test confirmed our conviction ensuing from the Britton and Gülgöz (1991) and McNamara and Kintsch (1996) studies, which is that principle-based revisions not only improve the textbase representations, they may also contribute to the development of situation models.

There were other experiments where the results were not so clear-cut. In an experiment where the effects of knowledge and cognitive motivation to elaborate on the text information were investigated (Gülgöz, Kumkale, & Aktunç, 1998), a text in Turkish on the Ottoman military structure was used. The text was revised and the readers were presented either the original or the revised text. Learning was measured by using a multiple-choice test and a cognitive structure test. There was no difference between the versions of the multiple-choice test and the difference on the cognitive structure test was marginal with a slight advantage for the revised version. The results of this experiment directed our attention to factors such as cognitive motivation and the types of learning measures used in the study. It is quite possible that the variations in the results might be affected by the measures used. As we have indicated before, our observations yield the possibility of a substantial relationship between text structure and the type of measure used. Some measures are more sensitive to influences of text structure whereas other measures do not seem to be affected. A detailed investigation of the measures which includes the cognitive processes required for each particular task may be a gateway to the understanding of the relationship between task and text structure. Finally, another observation that may be useful in explaining the results obtained may be that the text used in this particular study appeared to contain information that was familiar to most of the research participants.

In order to study the effects of the task specified in a study on learning, an experiment (Gülgöz, Kumkale, & Aktunç, 1998) was conducted where one-half of the subjects were given different learning instructions than the other half. One group was instructed to read the text so that they would be ready to take a test on it whereas each participant in the other group was told that they would be required to

teach the information in the text to another student who would be tested on the text content. The text used was also in Turkish and about economic policy decisions. The participants were all native speakers and their level of information retention was measured by a free recall test. When the instructed task differences were ignored, there were no differences between the recall levels of the readers of the original text and the revised version. There were however, complex interactions that included text version, the task, domain-specific prior knowledge, and the level of cognitive motivation. Because the explication of this interaction requires a complex and lengthy discussion, suffice it to say that the overall trend seems to be that the readers benefit from the revised version when they have a very limited knowledge on the text topic or when they do not have the tendency to elaborate and think extensively on text content.

The final study that we would like to mention here (Eskenazi, Aktunç, Kumkale, & Gülgöz, 1998) was not concerned with the retention of information as much as the actual processing of the text. For this study, we had a computer program developed for the presentation of the text. The program presented the text one segment at a time in a window that had an up arrow and down arrow next to it. The readers read the text at their own pace using the down arrows to move forward in the text and up arrows to go back to a segment viewed previously. The computer recorded the number of times that the readers viewed a particular segment and the amount of time spent in each viewing. The readers were presented either the original version or the revised version of the text on neural transmission that was used in an earlier study. The comparisons between text versions were made on three measures: the number of times the segments were viewed, the average duration spent reading the segments per viewing, and the total amount of time spent reading a segment. The results were interesting. There was no difference between the versions on the average reading duration per viewing but readers viewed the segments more frequently if they were given the original text, and the total amount of time they spent reading was significantly higher as well. The finding that there was no difference be-

tween the two versions in the amount of time spent reading each segment once, indicates that modifications made on the text did not change the structure of the segments. What was affected was the readers' need to go back to previous segments. This demonstrates that it was not the comprehensibility of the segments that was affected by the modifications but the connections between segments. The readers who had difficulty connecting a new segment to the representation felt the need to search the earlier segments to find a possible link.

This experiment was important from the perspective of the investigation of the processes affected by the text structure. We can observe that connected text takes less time to process than a text that contains gaps. There is no doubt that searching for links and making inferences take time and it is quite possible that by spending more time readers of the original text are able to achieve the same level of learning as the readers of the revised version. This finding is consistent with the finding in the Britton and Gülgöz (1991) study, showing that the readers of the revised version recalled more information per unit of time spent reading.

Summary and conclusions

When texts are revised, the general outcome is that the revisions are learned better than the original texts. Obviously, the revisers are motivated to accomplish better retention as a result of observing poorly written texts and they are convinced that they can improve them. In most of the cases that we reviewed we observed that the authors can and do improve them but without a specific strategy or model. Our work concerning learning from texts analyzed various variables and their relationship with text structure manipulated according to principles derived from the Kintsch model. In studying such relationships, we were able to observe that the revisions based on the principles delineate a trend. This trend, although often influenced by other variables, is that the implementation of the principles results in a text that is retained better in memory, sometimes only by readers with

little knowledge, sometimes by readers who are less motivated to elaborate on the content of the text, and sometimes by all readers. The impact of the text structure was affected by the task and the type of measure used to assess readers' learning levels. Despite these variations, the support for the revisions and the principles underlying those revisions seem to persist across a number of studies, across readers of various knowledge levels, language proficiency levels, and levels of tendency to think critically, across texts in two languages and on various topics. It should not come as a surprise that ensuring connections in a task facilitates the task of the learner, especially if the learner is not able to insert the connections for one reason or another. Interestingly, it was also observed that the connected text speeds up the processing of the text by alleviating the need for the reader to search for connections and make inferences.

There are some advantages of the revision system based on the principles. First, the revisions are based on a few principles unlike many other advisory guidelines on writing better texts. Second, the principles have the spirit of algorithms that can be applied easily and consistently. We have had the opportunity to observe that novices like undergraduate students not very familiar with the area of discourse processing could be instructed to apply these principles on texts successfully. Third, the analysis performed on the text reveals the underlying structure of the text and other problems related to the content and the structure. We have refrained from making such changes because we limited ourselves to achieving connectedness and assuring the right connections, but the implementation of the principles on the texts exposes the sections of text where there is a need for further improvement. If one is more concerned with the comprehensibility of the text than with loyalty to the principles then other areas of improvement in text make themselves evident through such analysis.

The major disadvantage in this sort of a revision strategy is the simulation program. The simulation program can be used once the text is transformed into propositions and this is a long, difficult, and tedious task. However, the good news is that our experiences indicate that the revisions can be

achieved without recourse to the simulation program. The revision strategy without the simulation program begins with breaking the text down into its clauses. Then the clauses are separated into two columns as those containing the information that will provide the connection to the mental representation and those that contain new information without altering the order of the clauses. Finally, the argument overlap is sought between the sentences. When the argument overlap cannot be established, the principles are applied to assure that one exists and the overlap is between those concepts that form the main issue in the text. It is particularly important to watch for the implementation of Principle 2 so that the clause that contains the repeated argument precedes the clause that offers new information. Thus a revision becomes possible without the simulation program.

There is a need to clarify certain questions with further research. One of the major issues in designing text for better learning is a methodological issue, that is, assessment of learning. Many different measures are used in the assessment of learning including the sorting task, multiple-choice questions, open-ended questions, free recall, and cognitive structure tests. It is difficult to claim that any one method is superior to another but it is also a fact that they require different retrieval mechanisms. Then, the evaluation of a method of assessment can be concerning the appropriateness of the test to the function of the text. The test that is used for the assessment of learning must match the purpose of the text and the use readers will have for the information in the text. From that perspective, we may find our assessment methods lacking. One can claim that the purpose of a text on neural transmission is not for test performance but for later use of that information in understanding some other phenomenon. This necessarily brings the discussion to the issue of constructing situation models but the quality of the situation model as a mental representation is even more complex to assess.

Another issue is that research reported in this article employed techniques that measured the retention of information for a short duration after the text was read. Consequently, we do not know much about the long-term retention

of text information and how it is affected by text structure.

Finally, we know that learning is also affected considerably by reader behaviors, characteristics, and tendencies

besides the actual processing of the text. Then, it is inevitable that we study such factors alongside text structure to arrive at more definitive strategies for designing texts.

References

- Beck, I. L., McKeown, M. G., Sinatra, G. M., & Loxterman, J. A. (1991). Revising social studies text from a text-processing perspective: Evidence of improved comprehensibility. *Reading Research Quarterly*, 26, 251–276.
- Britton, B. K., & Gülgöz, S. (1991). Using Kintsch's computational model to improve instructional text: Effects of repairing inference calls on recall and cognitive structures. *Journal of Educational Psychology*, 83, 329–345.
- Britton, B. K., Gülgöz, S., & Glynn, S. (1993). Impact of good and poor writing on learners: Research and theory. In B. K. Britton, A. Woodward, & M. Binkley (Eds.), *Learning from textbooks: Theory and practice* (pp. 1–46). Hillsdale, NJ: Lawrence Erlbaum.
- Britton, B.K., Stimson, M., Stennett, B., & Gülgöz, S. (1998). Learning from instructional text: Test of an individual-differences model. *Journal of Educational Psychology*, 90, 476–491.
- Britton, B.K., Van Dusen, L., Gülgöz, S., & Glynn, S.M. (1989). Instructional texts written by five expert teams: Revisions and retention improvements. *Journal of Educational Psychology*, 81, 226–239.
- Eskenazi, T. T., Aktunç, M. E., Kumkale, G. T., & Gülgöz S. (1998, September). Metin yapisi ile okuma davranisi arasindaki iliskiler [The relations between reading behavior and text structure]. Paper presented at the Tenth Annual Congress of Psychology, Ankara.
- Graves, R., & Hodge, A. (1943). *The reader over your shoulder*. New York: Macmillan.
- Graves, M. F., & Slater, W. H. (1986). Could textbooks and would textbooks. *American Educator*, 10, 36–42.
- Gülgöz, S. (1986). Retention differences between original and revised versions of texts. Unpublished master's thesis, University of Georgia, Athens.
- Gülgöz, S., Kumkale, G. T., & Aktunç, M. E. (1998, July). The effects of text coherence, need for cognition, and prior knowledge on situation models. Paper presented at the Eighth Annual Meeting of the Society for Text and Discourse, Madison, Wisconsin.
- Gülgöz, S., & Odabasi, B. (1998). Text comprehension in a foreign language. Unpublished manuscript.
- Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction–integration model. *Psychological Review*, 95, 163–182.
- Kintsch, W. (1994). Text comprehension, memory, and learning. *American Psychologist*, 49, 294–303.
- Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. Cambridge: Cambridge University Press.
- Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review*, 85, 363–394.
- McKoon, G., & Ratcliff, R. (1992). Inference during reading. *Psychological Review*, 99 (3), 1–27.
- McNamara, D. S., Kintsch, E., Songer, N. B., & Kintsch, W. (1996). Are good texts always better? Interactions of text coherence, background knowledge, and levels of understanding in learning from text. *Cognition and Instruction*, 14, 1–43.
- McNamara, D. S., & Kintsch, W. (1996). Learning from texts: Effects of prior knowledge and text coherence. *Discourse Processes*, 22, 247–288.
- Miller, J. R., & Kintsch, W. (1980). Readability and recall of short prose passages: A theoretical analysis. *Journal of Experimental Psychology: Human Learning and Memory*, 6, 335–354.
- Millis, K. K., & Graesser, A. C. (1994). The time-course of constructing knowledge-based inferences for scientific texts. *Journal of Memory and Language*, 33, 583–599.
- Noordman, L. G., Vonk, W., & Kempf, H. J. (1992). Causal inferences during the reading of expository texts. *Journal of Memory and Language*, 31, 573–590.
- Wenger, M. J., & Spyridakis, J. H. (1993). Reduced text structure at 2 text levels — Impacts on the performance of technical readers. *Journal of Technical Writing and Communication*, 23, 333–352.
- Zipf, G. K. (1949). *Human behavior and the principle of least effort*. Cambridge, MA: Addison-Wesley.

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