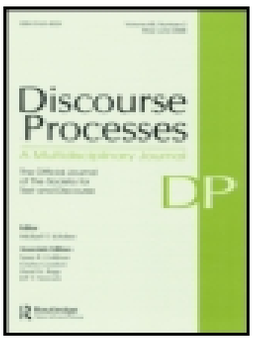

Discourse Processes

ISSN: 0163-853X (Print) 1532-6950 (Online) Journal homepage: http://www.tandfonline.com/loi/hdsp20

A code in the node: The use of a story schema in retrieval

Jean M. Mandler

To cite this article: Jean M. Mandler (1978) A code in the node: The use of a story schema in retrieval , Discourse Processes, 1:1, 14-35, DOI: 10.1080/01638537809544426

To link to this article: http://dx.doi.org/10.1080/01638537809544426

Published online: 11 Nov 2009.

DISCOURSE PROCESSES 1, 14–35 (1978)

A Code in the Node: The Use of a Story Schema in Retrieval*

JEAN M. MANDLER

University of California, San Diego (La Jolla)

Some characteristics of story schemata and their role in encoding and retrieval of stories are briefly described. Story schemata are described in terms of the story grammar outlined in Mandler and Johnson (1977). Using the rules of the grammar, canonical two-episode stories were generated as well as versions whose surface structure violated the posited underlying structure by interleaving the events of the two episodes. Predictions were made concerning the quantity, quality, and temporal sequencing of recall for the standard and interleaved versions. Recall by second-, fourth-, sixth-grade, and adult subjects was studied. Quantity of recall was less for the interleaved stories but more marked differences were found in the quality of recall; many more distortions and repetitions occurred in recall of interleaved stories. The most pronounced effects were found in sequencing of recall. Subjects hearing interleaved stories showed a strong tendency to recall stories in their canonical form rather than in the correct input order. This tendency was more pronounced for children. It was suggested that children are more dependent on familiar schemata for retrieval than are adults.

A major advance in our understanding of discourse processes has come from the recent attempts to characterize the structure of various kinds of prose. Much of this work has concentrated on the structure of stories (e.g., Kintsch, 1977; Mandler & Johnson, 1977; Rumelhart, 1975; Thorndyke, 1977). Each of these attempts has shown that stories have suprasentential structure, that subjects are sensitive to such structure, and use it to guide both comprehension and recall. For example, Thorndyke (1977) and Kintsch (1977) have shown that stories presented in scrambled order are less well recalled than those presented in normal order. Rumelhart (1977) has shown that rules governing the formation of summaries of stories may be derived from rules describing the underlying structure of stories. The present study explores in more detail some of the ways in which subjects use their knowledge of story structure to guide retrieval.

Many of the attempts to describe the structure of stories have been cast in the form of grammars, consisting of sets of rewrite rules capable in principle of generating well-formed stories or of breaking down a well-formed story into its

*This work was supported in part by NIMH Grants MH–24492 and MH–15828. It is based on research reported at the Society for Research in Child Development meetings, 1977. Requests for reprints should be sent to Jean M. Mandler, Department of Psychology, C–009, University of California, San Diego, La Jolla, California 92093.

constituent units. Mandler and Johnson (1977), following work by Rumelhart (1975) and earlier work by Propp (1968) and Colby (1973), characterized the underlying structure of simple stories as a set of basic nodes in a tree structure, each of which is either causally or temporally connected to other nodes in the tree. The rules governing the sequencing and connection of nodes were found to be adequate to parse a fairly large set of stories, including both single and multi-episode stories of several types.

Once a structural description of stories has been decided upon, there remains the yet more difficult task of specifying how people use such structure in encoding and retrieving the information in a story. Mandler and Johnson (1977) assumed that the structure of a story influences comprehension and recall because of the operation of story schemata. That is, the set of grammatical rules which specify whether or not a story is well formed is intended to represent expectations which a listener has incorporated in the form of a cognitive schema. Story schemata are acquired through experience with listening to stories as well as experience with typical kinds of causal and temporal event sequences in the world. Thus, story schemata consist of sets of expectations about stories, about the units of which they are composed, the way in which those units are sequenced, and the types of connections between units that are likely to occur.

THE USE OF STORY SCHEMATA DURING ENCODING

The cognitive schemata reflected by the grammar serve several functions during encoding. They provide a limited set of frameworks within which incoming material will be structured. They help the listener to know which aspects of the material are apt to be important or relevant. They also tell the listener when some part of the story is complete and can be stored or that some proposition must be kept in working memory because related material is yet to come.

Although some schema must be activated at the time of encoding if the material is to be comprehended, the selection process is guided by the details of the actual input. "Once upon a time" or some other aspect of the Setting of a story, for example, alerts listeners to expect a sequence of statements different from those they would hear if listening to a news report, a recipe, or a multiple-choice test. However, people have heard many different kinds of stories and can draw upon a variety of schemata to fit them. It is perfectly possible for subjects to "change their minds" as a story proceeds, to decide that they have gotten off on the wrong track, and to revise their notions of what the story is about. Reorganization can occur even after a story is finished (Spiro, 1977).

Mandler and Johnson (1977) described an explicit set of rules governing the structure of episodes in various kinds of stories, indicating which categories or nodes must be present and in what order. We were less explicit as to how a listener knows when one node is complete and the next begun. That is, we relied on an intuitive understanding of the characteristics of basic story categories. Although precise definitions remain to be formulated, it will be helpful to the

following discussion to give an informal description of the basic nodes in an episode and some of their characteristics which people use to decide when a particular node has been completed and a new one begun.

The first basic node in a story is a Setting, usually consisting of stative information about one or more characters, and often including information about the time and locale of the story. The Setting is often signaled by the use of formalisms, such as "Once upon a time..." The Setting is followed by one or more episodes, but only a single episode story will be considered here. The first basic node in the episode is a Beginning, which may be any sort of event. The clue to the listener that the Setting is complete and the Beginning node has been entered is usually a shift from a state description to an event description; the transition is often signaled by a formalism such as "Now, one day . . .," which indiates a shift to the time frame of the events in the first episode.

The listener exits from the Beginning and enters the next node, the Development, when there is a shift to a Reaction of a character. The shift is from an external to an internal event, at least implicitly connected by a causal relation; i.e., the event just described causes a character to react. By definition the reacting character becomes the protagonist of the episode. Thus, the Reaction node is central to the formation of an episode.[1] Typically, the Reaction node consists of two parts: a Simple Reaction, specifying the emotional response or what the protagonist thinks about the Beginning event, and a Goal, in which the protagonist formulates a plan to deal with any problem the Beginning may have created.

At this point the listener is set to hear about a Goal Path, necessary to complete the Development.[2] A Goal Path consists of an Attempt to reach the Goal and the Outcome of that attempt. The Attempt node must involve the protagonist in an effort to achieve the explicitly stated or implied goal and consists of a series of actions by the protagonist. The Outcome node is entered by some statement indicating whether the Attempt resulted in success or failure. Goal Paths are recursive, and if the Outcome was not successful, the listener should be prepared for either another Goal Path, or an Outcome-embedded episode (which will not be discussed here), or for the Ending node.

The Ending is difficult to describe informally because there are several options. In general, it consists of some further consequences, less directly connected to the Attempt than the Outcome. Frequently the Ending has the emphatic character of a resolution to a series of events. It often refers back to one or more previous nodes in the episode, and may also include a reaction on the part of

[1]Some of the ambiguities in understanding that arise when the Reaction node is omitted are discussed in Mandler and Johnson (1977).

[2]It is possible for an episode to consist of a Simple Reaction followed by an Action instead of a Goal Path, but this alternative schema seems to be relatively uncommon.

another character. If the story contains more than one causally connected episode, the reaction of another character may signal the creation of a new protagonist, and thus the Ending of one episode may commence a new episode.

We assume that a set of general rules of this sort enables a listener to structure incoming propositions while listening to a story. In some cases there are no choicepoints, as in the case of an Outcome following an Attempt. In others, particularly nodes at which new causally connected episodes may begin, there are several alternate routes which may be followed and the listener must keep previous nodes in mind until one or more subsequent nodes have occurred in order to organize all of the information into an appropriate structure. There are obviously a number of places even in a well-structured story where the listener may go wrong. If any nodes are omitted or are displaced from the ideal order, the chances of confusion or of encoding the information in terms of an unstable novel structure increase.

THE USE OF A STORY SCHEMA DURING RETRIEVAL

At the time of retrieval, subjects have at their disposal a set of ordered categories, whose approximate form is known independently of the details of the content. The schema serves as a code which operates in three ways during retrieval. First, it tells the subject what general sort of information is to be retrieved; that is, it points to a general area of memory. Second, it provides a temporal sequence to find specific content, telling subjects which address to move to next. Third, if the exact content of a category in the sequence cannot be retrieved, the schema allows the subject to generate an approximation, based on the structure of the schema itself, before moving on to the next address.

The operation of a story schema should produce specifiable characteristics of recall. For example, it accounts for certain kinds of additions and distortions. When the exact content of a node is not retrievable, the schema indicates that something is missing and provides a guide to the structural characteristics of the material to be substituted at that point. Similarly, the schema directs a particular output order of events. In the normal situation, the input and output order will be identical, but if the story has been presented in an irregular fashion, the output should be more likely to maintain the ideal order rather than the order actually heard.

The two main questions in the present report are how the activation of a story schema influences recall, and whether there are developmental differences in the use of a story schema as a retrieval mechanism. The first question was addressed by comparing recall of two types of story, one well-structured and the other deliberately violating the sequence of events prescribed by the grammar. Three influences of story structure on recall were assessed. (1) Quantity of recall: how much of a story is retrieved. (2) Quality of recall: how accurately the recalled units are expressed and the types of distortions and additions of new

material which occur. (3) Temporal sequence of recall: whether output of a story conforms to the input order, or whether it reflects the sequential order dictated by the ideal schema. Each of these questions is of interest not only for purposes of precise prediction about memory but because of the light the answers may cast on the structure of the schemata themselves. The tree structure formed by the rewrite rules of the grammar implies units of varying size, some of which may be more tightly connected than others. Accuracy and sequencing of recall should provide further information about the details of this structure.

Recall of ideally constructed two-episode stories, in which one episode followed the other, was compared with recall of interleaved versions of the same stories. In the interleaved versions each episode contained all the basic nodes in the correct order but the two episodes were mixed together rather than occurring successively. Each interleaved story began with a Setting node, followed by the Beginning of the first episode, followed in turn by the Beginning of the second episode. Next came the Reaction of the first episode, followed by the Reaction of the second, and so forth. Such interleaved stories sound slightly strange, since we are accustomed to the more traditional separated–episode versions of stories. Nevertheless the interleaved stories are comprehensible and even have an unusually symmetrical structure which one might think would make them memorable.

The interleaved stories are simple enough that listeners should be able to uncover their underlying structure. However, more processing will be required to do so than for standard stories. The advantage of connected discourse for memory is the very fact of connectedness. "Connectedness" implies the creation of larger units than individual words or sentences. We assume that these connections are formed in a working memory system of limited capacity in which material is temporarily stored until decisions are made about what goes with what. When such assignments have been made, the material can be relegated to long-term storage while the next set of statements is being processed.

When the incoming material fits a schema, this assignment is fairly easy, since each statement is related to the immediately preceding and following ones. The schema specifies when an episode has been concluded and can be transferred from working memory. In interleaved versions of stories twice as much material must be maintained in working memory before propositions can be assigned to their appropriate units. The extra load on working memory suggests that quantity, quality, and sequencing of recall should all be disrupted.

Quantity of Recall

Quantity of recall should depend on the extent to which each proposition is integrated with other propositions in the story. It is presumably easier to integrate the basic nodes of an episode if they are input contiguously. For example, for a listener to determine who is the protagonist of an episode, a Reaction must be related to a Beginning. If these two nodes are not input contiguously, the

listener must maintain the Beginning until the appropriate Reaction occurs in order to assign the various propositions to their relevant units. The farther apart the two nodes, the more likely the first will be forgotten or the wrong connection made.

Quality of Recall

"Quality" can be measured not only in terms of accuracy of reproduction of recalled nodes but also in terms of additions of new material and repetitions of old material. Some forgetting occurs even in well-formed stories and subjects attempt to replace nodes with new material (Mandler & Johnson, 1977). Since more nodes are expected to be missing in recall of interleaved stories, more additions should be expected. Furthermore, since the ideal schema is pointing to the wrong location for every other node in the input sequence, there should be more importations of material from the other interleaved episode. Repetitions, or backtracking, should occur as the subject tries to follow a sequential order which does not match the ideal order of the schema.

Temporal Sequence of Recall

Mandler and Johnson found that recall of well-structured stories almost always respected the input order. In a well-structured story, of course, structural order is identical to input order, so input–output correspondence cannot be assessed independently from structural order–output order correspondence. Thorndyke (1977) found that displacing certain nodes at input resulted in a tendency to recall them in the ideal order. Restle (1975) found more errors in answering questions about temporal sequences in a story that interleaved events involving two protagonists, when the questions required a comparison between two "threads" (episodes, in our terminology) than within a single thread. These findings suggest that the serial order in which propositions are input will have less influence on output order than will the ideal structural order of the schema used to encode the input. The technique of interleaving episodes should provide a systematic test of the extent to which subjects use an input order strategy or a schema-based strategy to retrieve the material.

DEVELOPMENTAL DIFFERENCES IN THE USE OF STORY SCHEMATA

The second main question of this study concerns developmental differences in the use of story schemata. To address this question, recall of standard and interleaved stories by children in the second, fourth, and sixth grades was studied as well as that of adults. Mandler and Johnson (1977) found that there were quantitative differences but few qualitative differences in recall of well-formed stories by children and adults. The data indicated that, at least by the first grade,

children have acquired story schemata and use them to organize their recall. The question of interest here is how children retrieve stories presented in unfamiliar format.

In traditional memory tasks, children recall less than adults and also show fewer signs that they use the organization of the presented materials to order their output during recall. For example, in studies of recall of lists of categorized words presented in random order, adults reorganize the randomly presented input and cluster their output into familiar categories. Children do not accomplish such reorganization when the structure of the materials is not obvious to them at the time of presentation. When helped to discover the structure of the lists through techniques such as blocking or sorting (Cole, Frankel, & Sharp, 1971; Worden, 1974), clustering of recall becomes more similar to that of adults, although quantitative differences in output remain.

We assume that the structure of stories is both more familiar and more obvious to children than the structure of lists of words. Data from Mandler and Johnson (1977) and Stein and Glenn (1978) have shown that young children are sensitive to the structure of stories and use that structure to order their recall, without specific instructions or assistance from the experimenter. Brown and Murphy (1975) showed that children as young as four years were better at recalling a series of pictures depicting narrative or logical sequences than random or scrambled ones. They were also better at maintaining the correct ordering in recall of the narrative and logical sequences. Of most interest for present purposes was their finding that given a scrambled series of pictures which violated an expected or logical order of events, a sizable proportion of errors in output sequencing stemmed from the children's producing the narrative or logical order rather than the actually presented order.

These data are in accord with the hypothesis offered by Mandler and Robinson (1978) that children's retrieval processes are more dependent on familiar schemata than those of adults. This hypothesis has two implications, one involving quantity of recall, the other temporal sequencing of output. The first is that memory for material conforming to familiar, as opposed to unfamiliar structures will be *relatively* better for children than for adults (Mandler & Day, 1975; Mandler & Robinson, 1978). The second is that children should be less able to maintain an unfamiliar serial order during output but should retrieve material according to the structures that are more familiar to them.

In the case of stories presented either in standard or in interleaved format, we assume that both children and adults will recognize that the stories have narrative structure and will use that structure to comprehend and retrieve the material. We would expect children to be more disrupted by the unfamiliar format and so to show quantitatively poorer recall of the interleaved stories. In terms of sequencing of output, we assume that adults will be able to produce interleaved stories in interleaved fashion more readily than will children. This hypothesis leads to the perhaps counterintuitive prediction that children's recall of scrambled stories will be clustered into separate episodes more than will adults'.

METHOD

Subjects

Ninety-six subjects participated in the experiment, 24 from each of four age groups: second grade, mean age 7;7, fourth grade, mean age 9;7, sixth grade, mean age 11;4, and college students, mean age 19;6. The children were from a predominantly middle class public elementary school in San Diego, and the college students were from the University of California, San Diego.

Materials

Four simple two-episode stories were constructed according to the story grammar outlined in Mandler and Johnson (1977). Each story had a common Setting, followed by two Then-connected episodes. This structure is a loose one, in which the protagonist and events of the second episode bear only a temporal relation to the first. However, in all stories the events made a sensible whole, united by the common Setting in which protagonists from both episodes were introduced.

Each standard story was then rearranged to create an interleaved version. In these versions, following the Setting, the five basic nodes of each episode were presented in interleaved fashion: two Beginnings (Beginning 1, followed by Beginning 2), two Reactions, two Attempts, two Outcomes, and two Endings. In these sets of paired nodes, the node from Episode 1 was always presented first. Examples of a standard and interleaved story and their division into the basic nodes are shown in Table 1. The propositions in both are identical except for occasional substitution of proper nouns for pronouns in the interleaved versions to provide unambiguous referents. An abbreviated representation of their common underlying structure is shown in Fig. 1. The figure does not include the connections between nodes and also omits the subdivision of the Reaction node into Simple Reactions and Goals (see Mandler & Johnson, 1977, for a more detailed representation of the underlying structure).

Each basic node consisted of one or two propositions. Number of propositions was balanced across episodes, so that each story had an equal number of propositions for each type of node. For the Reaction node, half of the episodes had both a Simple Reaction proposition and a Goal proposition; the other half had either a Simple Reaction or a Goal.

Design and Procedure

The design was a 2 X 4 between-subjects matrix, varying story type and age. In each of the four age groups, 12 subjects listened to four normal stories and 12 listened to four interleaved stories. Subjects were tested individually. They were told we were interested in how people remember stories, and then listened to four stories presented successively on a tape recorder. Order of presentation was

TABLE 1
An Example of a Standard and Interleaved Story[a]

	Standard version
Setting	Once there were twins, Tom and Jennifer, who had so much trouble their parents called them the unlucky twins.
Beginning 1	One day, Jennifer's parents gave her a dollar bill to buy the turtle she wanted, but on the way to the pet store she lost it.
Reaction 1	Jennifer was worried that her parents would be angry with her so she decided to search every bit of the sidewalk where she had walked.
Attempt 1	She looked in all the cracks and in the grass along the way.
Outcome 1	She finally found the dollar bill in the grass.
Ending 1	But when Jennifer got to the store, the petstore man told her that someone else had just bought the last turtle, and he didn't have any more.
Beginning 2	The same day, Tom fell off a swing and broke his leg.
Reaction 2	He wanted to run and play with the other kids,
Attempt 2	So he got the kids to pull him around in his wagon.
Outcome 2	While they were playing, Tom fell out of the wagon and broke his arm.
Ending 2	Tom's parents said he was even unluckier than Jennifer and made him stay in bed until he got well.
	Interleaved version
Setting	Once there were twins, Tom and Jennifer, who had so much trouble their parents called them the unlucky twins.
Beginning 1	One day, Jennifer's parents gave her a dollar bill to buy the turtle she wanted, but on the way to the pet store she lost it.
Beginning 2	The same day, Tom fell off a swing and broke his leg.
Reaction 1	Jennifer was worried that her parents would be angry with her, so she decided to search every bit of the sidewalk where she had walked.
Reaction 2	Tom wanted to run and play with the other kids.
Attempt 1	Jennifer looked in all the cracks and in the grass along the way.
Attempt 2	Tom got the kids to pull him around in his wagon.
Outcome 1	Jennifer finally found the dollar bill in the grass.
Outcome 2	While the kids were playing, Tom fell out of the wagon and broke his arm.
Ending 1	But when Jennifer got to the store, the petstore man told her that someone had just bought the last turtle, and he didn't have any more.
Ending 2	Tom's parents said he was even unluckier than Jennifer, and made him stay in bed until he got well.

[a]Basic nodes are listed at the left.

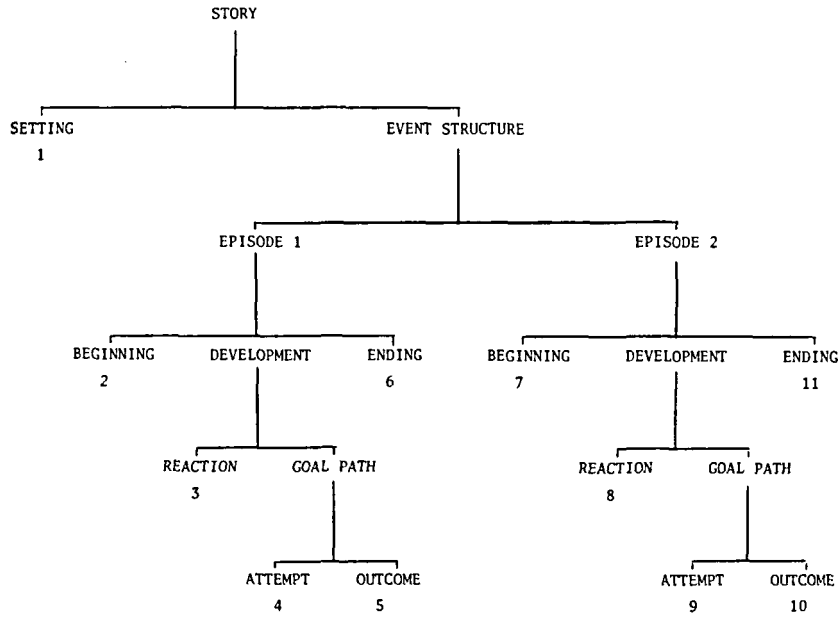

FIG. 1 The underlying structure of all the standard and interleaved stories used in this study. Connections between nodes have been omitted as well as details below the basic nodes represented. The numbers beneath the nodes provide the input order for standard stories.

counterbalanced across subjects. Twenty-four hours later, subjects were asked to recall everything they could remember from the stories. Order of recall of stories was the same as order of presentation; recall was cued by providing the title of each story.

Scoring Procedures

The tape-recorded protocols were transcribed and then divided into propositions. Two criteria of recall of propositions were used. The first was a strict criterion (Category 1), in which two raters agreed that the essential meaning of a proposition had been reproduced. The second was a loose criterion and included two additional categories. Category 2 consisted of propositions which distorted the meaning of a proposition or which expressed only a subsidiary part such as a temporal clause, leaving out the main event being described. Propositions about which the raters disagreed as to whether the meaning had been adequately expressed were also included in this category. Category 3 consisted of structural additions, i.e., propositions which filled the structural requirements of a node but consisted of unrelated or wrong material.

Additions, i.e., material which had not been included in the original stories were divided into two classes: reasonable additions and distortions. Reasonable

additions included three types: (1) *Redundancies,* i.e., saying the same thing twice, often in a slightly different way. Redundancies appeared sometimes to be a kind of delaying action, the subject repeating something before retrieving the next proposition, and sometimes to insure that the experimenter understood what the subject meant. (2) *Reasonable presuppositions,* in which obviously inferable material was added to the original proposition. For example, in the Unlucky Day story (see Table 1), the Attempt might include the phrase "She retraced her steps" before continuing with the original proposition. (3) *Exaggerations,* in which a statement was intensified in some way. For example, a storm which blew down some houses in one story was occasionally referred to as a terrible hurricane or a tornado. Although an attempt was made to separate these three kinds of reasonable additions, it was not always possible. A storm which blows down houses is apt to be a hurricane or a tornado and thus might be classed as a reasonable presupposition rather than an exaggeration. For statistical analyses the three types of reasonable additions were grouped into a single category.

Distortions included four types: (1) *Repetitions of previously recalled nodes,* in which other nodes were produced before the repetition. (2) *Character and event confusions.* These distortions consisted of importations from one episode into another, or from one node to another within the same episode. Typical examples of character confusion were a single character being used as the protagonist for both episodes or a character from one episode appearing in the other. In the Unlucky Day story, for example, Tom might help his sister find her money. An example of an event confusion would be Tom losing some money instead of or in addition to breaking his leg. (3) *Irrelevant or wrong material added to a correctly recalled node.* This type of addition was in marked contrast to reasonable presuppositions; although frequently related to the story line, it could not be assumed to be the case. For example, the subject might say "Tom broke his arm and had to go to the hospital," before continuing with the rest of the episode. (4) *Structural additions.* This category consisted of irrelevant or wrong material which was substituted for an entire node. For example, in the Unlucky Day story it might be recalled that the girl found her dollar. Not being able to retrieve the Ending, the subject might say, "She felt glad and went home."

As in the case of reasonable additions, there was some overlap among these categories and they were grouped into a single class for statistical analysis. For example, a structural addition might contain material from the other episode and thus represent a character or event confusion as well. In addition, there was partial overlap between the scoring of distortions and the loose criterion for propositions recalled. The loose criterion included all the structural additions and also included propositions in which major character or event distortions occurred. The general class of additions, on the other hand, included many relatively minor distortions. For example, the subject could correctly recall a proposition and yet add new or distorted material to it. In this case, a subject would

be credited with correct recall and at the same time be scored as having made an addition.

RESULTS

Quantity of Recall

The same number of stories was recalled in both the standard and interleaved story conditions (in each case, 170 out of 192, or 89%). However, of the stories recalled, more entire episodes were omitted in the standard story condition (14%) than in the interleaved story condition (4%). The Then-connection between two episodes is a loose one (cf. Mandler & Johnson, 1977), and in the standard story condition the story is "complete" when one episode has been retrieved. In an interleaved story the material from both episodes is continuously interwoven during input, and this fact was apparently sufficient to increase the likelihood that something from both episodes would be recalled. In order to compare the effects of interleaved versus standard story structure on patterns of recall, therefore, the main analyses were carried out on the mean number of nodes recalled per episode, given that the episode was recalled at all.

A 2×4 analysis of variance, using the strict criterion, compared recall of nodes in the two story conditions and the four age groups. Amount recalled increased with age, from 3.0 nodes per episode in the second grade to 3.8 nodes for adults, $F(3, 88) = 8.26$, $p < .001$. More nodes per episode were recalled from the standard stories (3.5) than from the interleaved ones (3.2), $F(1, 88) = 5.07$, $p < .05$. The interaction between age and condition did not reach significance, $F(3, 88) = 2.07$, $p = .11$. However, since it had been predicted that children would have relatively more difficulty in recalling interleaved stories than adults, individual comparisons were carried out between successive age groups for the two types of story. For interleaved stories, there was no significant change in amount recalled from the second to the sixth grade, but significant improvement from sixth grade to adult, $F(1, 88) = 5.90$, $p < .05$. For standard stories there was significant improvement in recall from the second to fourth grade, $F(1, 88) = 4.72$, $p < .05$, and no significant change thereafter. This pattern of results, illustrated in Fig. 2, is very similar to that found for recognition of familiar and unfamiliar pictures in two previous studies (Mandler & Day, 1975; Mandler & Robinson, 1978). The most descriptive characterization of Fig. 2 is that the second-graders recalled relatively little of either type of story, the adults showed equally good recall of both types, and the fourth- and sixth-graders were also good at recalling standard stories but had more trouble in recalling interleaved stories.

When the same analysis was carried out using the loose criterion of recall, which included distorted and incompletely recalled nodes as well as nodes in

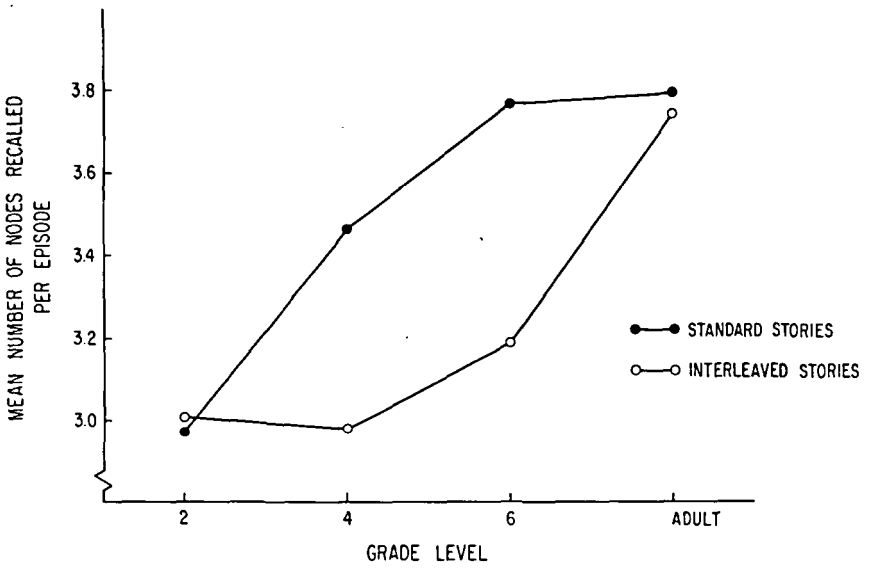

FIG. 2 Mean number of nodes recalled per episode for standard and interleaved stories by four age groups (second-, fourth-, sixth-grade, and adults).

which new material was substituted (Categories 2 and 3 of the recall criteria), the age trend remained, $F(3, 88) = 9.44$, $p < .01$, but the difference between standard stories (3.7 nodes per episode) and interleaved stories (3.5 nodes) was no longer significant, $F(1, 88) = 2.12$. Another way of expressing this result is to consider separately the number of nodes per episode which fell into Categories 2 and 3. This analysis showed .81 distorted nodes per episode for the interleaved stories and .57 distortions for the standard stories, $F(1, 88) = 5.03$, $p < .05$. This combination of findings shows how difficult it is to separate entirely quantity from quality of recall of complex material. Subjects listening to interleaved stories produced approximately as many nodes per episode as subjects listening to standard stories; however, more of the nodes were distorted or confabulated. It seems clear that in both conditions subjects were sensitive to the general episodic structure of the material and frequently attempted to produce something for nodes whose exact content could not be located in memory.

An analysis was also carried out on the types of node recalled. This analysis included the Setting nodes, which since they occurred only once per story, were scored on the basis of number of stories recalled, rather than number of episodes. Given that they recalled an episode, subjects in the standard story condition retrieved 72% of the nodes in comparison to 67% in the interleaved story condition, $F(1, 88) = 4.51$, $p < .05$. There were major differences in recall of the various types of node, $F(5, 440) = 91.20$, $p < .001$. Newman-Keuls tests showed that Reactions and Endings were significantly less well recalled than the other nodes

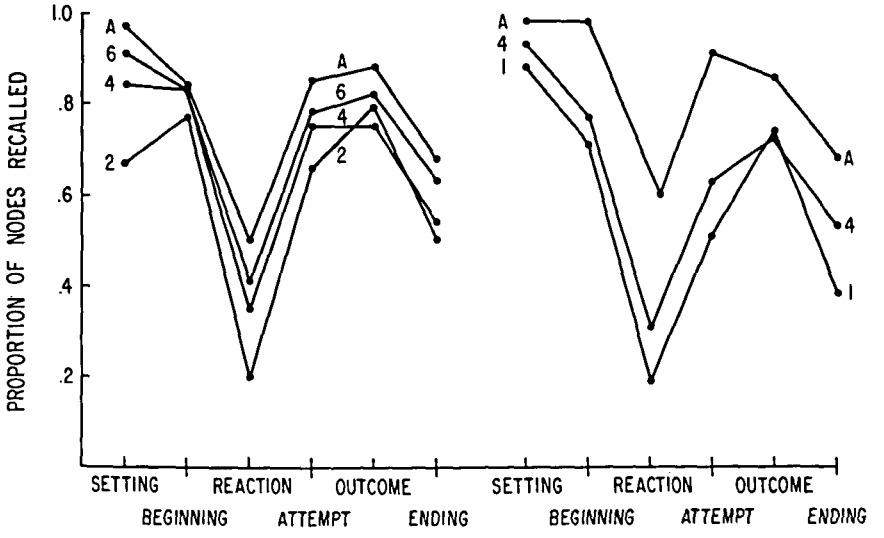

FIG. 3 Left panel: Proportion of each type of node recalled by four age groups (second-, fourth-, sixth-grade, and adults) in the present study. Right panel: Data for three age groups (first-, fourth-grade, and adults) taken from Mandler and Johnson (1977). The abscissa represents the ideal sequential order of nodes.

($p < .001$ in both cases), which did not differ significantly from each other. The interaction between story type and type of node recalled was not significant, indicating that the loss of recall in the interleaved story condition was relatively uniform across nodes.

Percentage of nodes recalled increased from 60% in the second grade to 79% for adults, $F(3, 88) = 11.15, p < .001$. The overall pattern of recall of the different types of node and the developmental trends in recall are strikingly similar to those found by Mandler and Johnson (1977), although in the present experiment the age X type of node interaction did not reach significance, $F(15, 440) = 1.49, p = .10$. The age differences in recall of the various types of nodes are shown in Fig. 3, in conjunction with the previous data from Mandler and Johnson.[3] A remarkable degree of consistency between the two studies appears, in spite of quite different sets of stories being used.

A separate analysis was carried out on the recall of the Reaction node in order to assess recall of its two subtypes: Simple Reactions and Goals. Goals are more central to the overall meaning of an episode, and not surprisingly propositions representing Goals were better recalled (32%) than propositions represent-

[3]The data from the previous study were expressed in terms of mean number of propositions recalled per node. In Fig. 3, the data have been expressed in terms of mean proportion of nodes recalled.

ing Simple Reactions (22%), $F(1, 88) = 15.01$, $p < .001$. What is somewhat surprising is the generally low level of recall of Goals. Goal propositions may be omitted from recall because of their redundancy with the following Attempts, which in most cases make the Goal-directed motivation clear. Both Simple Reactions and Goals were less well recalled from interleaved stories (22%) than from standard stories (31%), $F(1, 88) = 6.95$, $p < .01$, and children recalled fewer of both than did adults, $F(3, 88) = 15.01$, $p < .001$. Although the youngest children had particularly low recall of Simple Reactions and Goals (11 and 18%, respectively), even adults show poorer recall of these types of proposition (33 and 38%) than any others.

Quality of Recall

Mean number of reasonable additions and distortions per story for standard and interleaved story conditions and the four age groups are shown in Table 2. There were more additions in the interleaved story condition, $F(1, 88) = 14.64$, $p < .001$, and an interaction of story type with type of addition (reasonable or distorted), $F(1, 88) = 20.73$, $p < .001$. As can be seen in Table 2, approximately the same number of reasonable additions occurred in the two types of story. Distortions in standard stories also occurred at about the same rate as reasonable additions, but more than twice as many distortions were found in recall of interleaved stories. Total number of additions increased with age, $F(3, 88) = 10.84$, $p < .001$, but for all grade levels there were more distortions in the interleaved than in the standard story condition. There was also an interaction of addition type with grade level, $F(3, 88) = 2.83$, $p < .05$. In the three groups of children there were more distortions than reasonable additions, but for adults there were approximately the same number of each type. In general, the adults were more redundant and explanatory in their recall protocols. They also tended to add commentaries and homilies about the stories (not included in the analyses) which were virtually absent from the children's protocols.

TABLE 2
Mean Number of Additions and Distortions per Story in Standard and Interleaved Story Conditions for Four Age Groups

	Additions		Distortions	
	Standard	Interleaved	Standard	Interleaved
2nd grade	.21	.19	.48	1.10
4th grade	.58	.69	.68	2.32
6th grade	.80	1.07	1.01	2.24
Adult	1.81	1.40	1.12	2.06
Mean	.85	.84	.82	1.93

TABLE 3
Total Number of Distortions and Percentage of Each Type Occurring in Standard and Interleaved Stories

	Standard		Interleaved	
Repetitions of nodes	16	(16%)	85	(84%)
Character and event confusions	51	(29%)	123	(71%)
Structural additions	41	(36%)	72	(64%)
Irrelevant or wrong material	39	(41%)	55	(59%)

The total number of each type of distortion (described in the Method section) in standard and interleaved stories is shown in Table 3. The largest difference between the two story types was in repetitions of nodes. Subjects recalling interleaved stories produced more than four times as many repetitions of nodes as subjects in the standard story condition. Most of the repetitions appeared to be an attempt to output a story according to both the interleaved and standard structures. Eighty-one percent of the repetitions in interleaved stories either preceded or followed a structurally adjacent node from the same episode; in 61% of these cases the repetition preceded the next node from the same episode. The typical occasion for a nodal repetition was a transition from recall of several interleaved nodes to at least two nodes from the same episode, e.g., a recall sequence of Beginning 1, Beginning 2, Attempt 1, Attempt 2, Attempt 1, Outcome 1, Ending 1.

There were more than twice as many character and event confusions in the recall of interleaved stories as in standard stories. There were also more structural additions and irrelevant or wrong material, but in these cases the difference between the two types of story was smaller. There were fewer opportunities to fill a node with new material in the case of standard stories because of better overall recall; however, adding new material and inventing material to fill an irretrievable node were relatively more frequent than confusions and repetitions in standard stories.

Temporal Sequencing of Recall

The major question of interest is the extent to which subjects in the interleaved story condition followed the input order or the ideal structural order in sequencing their output. In all of the temporal sequence analyses the loose criterion for recall was used. In assessing the extent to which output was interleaved, it seemed appropriate to include all recalled nodes, since even distorted nodes and structural additions could be clearly assigned to one episode or the other. The first comparison was made on the four age groups in the interleaved story condition.[4] Each subject's data were scored in terms of the percentage of

[4]Data from the standard story condition are not inlcuded in these analyses since, with rare exceptions, recall followed the ideal (input) order.

TABLE 4
Percentage of Episodes Recalled Sequentially as a Unit from Interleaved Stories and RRR Clustering Scores for the Four Age Groups

	% Recalled as units	RRR
2nd grade	49.1	.74
4th grade	47.5	.72
6th grade	29.2	.68
Adult	5.5	.52

times episodes were recalled sequentially in a single unit, unbroken by any propositions from the other episode. These percentages are shown in the first column of Table 4. There was a much greater tendency for the children to sequence their recall according to the ideal structure than for the adults, $F(3, 44) = 7.91$, $p < .001$. Although the tendency appears to decline by the sixth grade, the three children's groups did not significantly differ from each other.

Although very few adults in the interleaved story condition recalled any episodes completely in the ideal order, neither did they perfectly interleave their output according to the input order. Only 2 out of 170 stories were perfectly interleaved. Subjects usually produced a compromise between the two orders. The Relative Ratio of Repetition (RRR) was computed for each subject's output sequence data (Mandler, 1969). RRR, which ranges from 0 to 1.0, assesses the extent to which items are clustered into categories during recall. In this case, items were nodes and the categories were the two episodes. The RRR scores for the four age groups in the interleaved story condition are shown in the second column of Table 4.

All groups produced a substantial amount of clustering into episodes, but adults had significantly lower scores than any of the groups of children, $F(3, 44) = 4.54$, $p < .01$. The clustering data presented in Table 4 probably underestimate the developmental trend somewhat, because of the positive relationship between the RRR measure and number of items recalled. Of the various available clustering measures, RRR is less related to quantity of recall than most, but nevertheless the positive relationship even if small is troublesome in developmental research (Murphy, Puff & Campione, 1977). Typically, as in the present study, adults recall more than children, and can therefore be expected to show higher clustering scores. The fact that in spite of their greater recall their clustering scores were lower than those of children suggests that the weakening of the relationship between recall and ideal structure is even greater than the scores presented in Table 4 indicate.

To determine if certain pairs of adjacencies in output were more likely to occur than others two measures were computed. The first consisted of the probability that two structurally adjacent nodes from the same episode (e.g., Beginning 1 and Reaction 1, or Attempt 2 and Outcome 2) were recalled together in correct sequential order, given that both were recalled. The second measure consisted of

TABLE 5
Probability that Structurally Adjacent Nodes and Input Adjacent Nodes Were Recalled Sequentially[a]

	Structurally adjacent nodes				
	B1–R1 + B2–R2	R1–A1 + R2–A2	A1–O1 + A2–O2	O1–E1 + O2–E2	
2nd grade	.78 (12)	.72 (11)	.82 (41)	.65 (34)	
4th grade	.73 (26)	.86 (25)	.85 (49)	.62 (38)	
6th grade	.61 (29)	.50 (30)	.77 (66)	.61 (53)	
Adult	.64 (45)	.58 (46)	.58 (75)	.69 (70)	
Mean	.69	.66	.76	.64	
	Input adjacent nodes				
	B1–B2 + B2–R1	R1–R2 + R2–A1	A1–A2 + A2–O1	O1–O2 + O2–E1	E1–E2
2nd grade	.48 (26)	.44 (13)	.10 (34)	.23 (33)	.15 (15)
4th grade	.33 (35)	.10 (21)	.07 (43)	.10 (45)	.62 (14)
6th grade	.50 (51	.15 (22)	.06 (66)	.10 (59)	.47 (20)
Adult	.55 (67)	.26 (34)	.26 (72)	.17 (73)	.40 (30)
Mean	.46	.24	.12	.15	.41

[a]Number of occurrences on which each probability is based is shown in parentheses.
Note: B = Beginning; R = Reaction; A = Attempt; O = Outcome; E = Ending. 1 refers to first episode; 2 to the second episode.

the probability that two nodes adjacent at input were recalled together in correct input order, again given that both were recalled. For example, when subjects have recalled Beginning 1 if they follow the structural order they will next recall Reaction 1; if they follow the correct input order they will next recall Beginning 2. Similarly, once Beginning 2 has been recalled, the structural order dictates recall of Reaction 2, whereas the input order dictates recall of Reaction 1.

These two types of conditional probability, for each of the structural pairs and the relevant adjacent input pairs, are shown in Table 5.[5] It can be seen from the table that structurally adjacent nodes were more likely to be recalled together than input adjacent nodes. The most likely pair of nodes to be recalled sequential-

[5]The probabilities of structurally adjacent and input adjacent pairs, such as Beginning–Reaction and Beginning 1–Beginning 2, can sum to more than 1.0. A subject might recall Beginning 1, Beginning 2, Reaction 2 in that order, omitting Reaction 1 altogether. If such a pattern should occur in all stories, that subject would receive a conditional probability of 1.0 for both the structurally adjacent and input adjacent pairs. To the extent that pairs were not recalled together, or were recalled in the wrong order, the sum of the two probabilities will be less than 1.0.

ly was Attempts and Outcomes (.76). This proportion may be contrasted with the likelihood that Attempts were followed by the next input node (Attempt 2 or Outcome 1); the proportion was only .12.

The relative degree of dependency on the various types of structurally adjacent pairs versus their related input adjacent pairs was assessed by computing difference scores for each subject. For each type of structurally adjacent pair the related input pair probability was subtracted from the structurally adjacent pair probability. Positive scores indicate that subjects were following the structural order more than the input order. Because of the relatively low recall by second-graders, there were a number of missing cells for some children in this group. Therefore, the analysis considered only fourth- and sixth-graders and adults. The results showed a general decline with age in the tendency to recall structurally adjacent pairs together. The mean difference scores were .61, .43, and .31 for the fourth grade, sixth grade, and adults respectively, $F(2, 33) = 4.10$, $p < .05$. The difference scores also varied for the four pair types, $F(6, 99) = 5.96$, $p < .001$. The difference scores for Beginnings and Reactions (.21) were significantly lower than the others. The scores for Attempts and Outcomes were the highest (.60); Reactions and Attempts (.47) and Outcomes and Endings (.51) fell in between.

Comparison of the several analyses indicates that subjects were able to maintain the interleaved input order fairly well through the Beginnings of both episodes, but then tended to revert to the ideal structural order to sequence the rest of their recall. Not infrequently they would also append a previously omitted Ending at the end of their recall, resulting in a relatively high Ending1–Ending 2 adjacency score (see Table 5).

A final analysis of sequencing of recall concerned inversions of correct structural order within episodes for both types of story. This analysis compared the occasions on which subjects recalled a later node from an episode before an earlier node. It considered only the output order of nodes from a given episode, whether the two episodes were interleaved in recall or not. As found previously by Mandler and Johnson (1977) for well-formed stories, there were very few such temporal inversions. Although more inversions occurred in the interleaved story condition (.33 nodes per story) than in the standard story condition (.25 nodes per story), this difference was not significant nor were there any significant differences among the various age groups. It appears that a story schema has a strong temporal structure, which is sufficient to maintain the ordering of events even when they are input in irregular fashion. It is possible to create disruption in the ordering of events in recall (cf. Stein, 1976), but only under conditions of more extreme distortion of input than used in this study.

DISCUSSION

The data presented here demonstrate powerful effects of a story schema on recall. Even when stories were presented in an unusual interleaved fashion, re-

quiring subjects to keep track of two episodes simultaneously, the underlying ideal structure of the story schema played an important role in retrieval. More distortions and confusions were evident in recall of interleaved stories, but subjects clearly knew what kinds of units had been presented and attempted to produce some relevant content for each. Thus, the schema directs retrieval toward particular locations in memory. If the subject has successfully recalled an Attempt, for example, the schema next directs a search for a related Outcome. If it cannot be retrieved, then the subject knows approximately what kind of material to produce.

The working of the schema can also be seen in the *kinds* of distortions produced in recall of interleaved stories. It is not the case that retrieval merely breaks down for irregularly presented material. Entire stories were no more likely to be forgotten in the interleaved story condition than in the standard story condition. Rather, the content of the interleaved episodes became confused in systematic ways. Two kinds of distortion were common. In the first, the two-episode structure of a story was kept relatively intact, but a single character became the common protagonist for both episodes. Typically such reorganization resulted in the two episodes being recalled sequentially. The other common distortion was to create a single episode out of material taken from both. Although no complete example of this type of reconstruction occurred in the Unlucky Day story, perhaps because the content of the nodes in its two episodes was so different, a representative illustration would be a recall protocol consisting of Jennifer's going to the store to buy a turtle, on the way falling down and breaking her leg, and then having to stay in bed until she got well. Here two episodes have been turned into one, but the single episode reflects the structural requirements of a story schema.

Equally dramatic effects of an ideal schema were found in the sequencing of recall. Subjects of all ages tended to cluster the interleaved stories into separate episodes. Adults were better able to maintain the interleaved structure than were children, but even the adults were not notably successful. The further recall proceeded the more likely was the interleaving of output to break down and recall to revert to the ideal order. The large number of repetitions of previously recalled nodes was another indication of the difficulty of maintaining the interleaved structure. The more familiar schema appeared to override the attempt to reproduce the less familiar serial input order. The schema dominated the recall process to such an extent that when the unstable input organization was no longer useful in directing recall, subjects backed up and tried again, using the schema to produce a run of material from the same episode.

It is clear, however, that most subjects used both strategies to access the stored material. The analysis of the conditional probabilities of output adjacencies indicated that the story schema was the preferred retrieval method. It is not possible from a simple study of recall to determine whether a story schema is merely a preferred access route, or a generally more successful one than a novel serial

input structure. Other experimental paradigms must be used to address this problem.

The developmental data indicated that the story schema was much more prominent as a retrieval strategy for the children than for the adults. The data suggest less flexibility on the part of children in the sense of their having fewer routes into the storage system. In general, the children had relatively more difficulty in retrieving the interleaved stories. This difficulty might stem from confusions occurring at the time of encoding material presented in unfamiliar format, or it might arise from their overreliance on the story schema as a recall strategy; one access route may not be as good as two. It would be instructive to require both children and adults to order their recall in the two different ways, to compare the efficiency of the two strategies.

Recall data alone also do not speak directly to the issue of the way in which interleaved stories are represented in memory. The present data are compatible, however, with the hypothesis that the stories are represented in their ideal schematic form of two separate episodes, perhaps tagged with an interleaving algorithm, at least by the adults. The analysis of the conditional probabilities of output adjacencies indicated a closer connection between Attempts and Outcomes than between other pairs of nodes, suggesting that these two nodes may be especially tightly linked in the storage system. For all subjects the tendency to produce these two nodes together was very strong, even when otherwise following the interleaved pattern fairly successfully. It was also noted that nodes containing more than one proposition were rarely separated in recall by material from another node, suggesting that nodes were encoded and stored as units. It seems probable that the higher level nodes, such as Episode itself, are represented in memory as units as well. However, to test this hypothesis we must move out of the recall paradigm to probe question and reaction time experiments.

Finally, the children's clustering data in this experiment contrast rather sharply with the many studies of children's recall of lists of words. Even when lists have a categorical structure well known to children, unless given special training they tend not to use that structure to access the stored material. However, their use of a familiar structure to access connected discourse was dramatically evident in the clustering data of the present study. Even when the material was input in irregular fashion, the children reorganized it in terms of canonical story structure. Thus, the basic organization of memory appears quite similar in children and adults. When children deal with prose structure which is meaningful to them and with which they have had extensive experience, they not only use that structure but depend on it to organize recall even more than do adults.

ACKNOWLEDGMENTS

I wish to thank the San Diego Unified School District and the staff and students of Doris Miller Elementary School for their cooperation. I am especially grateful to Marsha DeForest who helped write the stories and contributed to the scoring scheme, to Barbara Vance who

REFERENCES

Brown, A. L., & Murphy, M. D. Reconstruction of arbitrary versus logical sequences by preschool children. *Journal of Experimental Child Psychology*, 1975, *20*, 307–326.

Colby, B. N. A partial grammar of Eskimo folktales. *American Anthopologist*, 1973, *75*, 645–662.

Cole, M., Frankel, F., & Sharp, D. Development of free recall learning in children. *Developmental Psychology*, 1971, *4*, 109–123.

Kintsch, W. On comprehending stories. In P. Carpenter & M. Just (Eds.), *Cognitive processes in comprehension*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1977.

Mandler, G. Input variables and output strategies in free recall of categorized lists. *American Journal of Psychology*, 1969, *82*, 531–539.

Mandler, J. M., & Day, J. Memory for orientation of forms as a function of their meaningfulness and complexity. *Journal of Experimental Child Psychology*, 1975, *20*, 430–443.

Mandler, J. M., & Johnson, N. S. Remembrance of things parsed: Story structure and recall. *Cognitive Psychology*, 1977, *9*, 111–151.

Mandler, J. M., & Robinson, C. A. Developmental changes in picture recognition. *Journal of Experimental Child Psychology*, 1978, in press.

Murphy, M. D., Puff, C. R., & Campione, J. C. Clustering measures and organization theory. Paper presented to the Society for Research in Child Development, New Orleans, March, 1977.

Propp, V. *Morphology of the folktale*. Augustin: University of Texas Press, 1968. (Originally published, 1928.)

Restle, F. Answering questions from cognitive structures. In F. Restle, R. M. Shiffrin, N. J. Castellan, H. R. Lindman, & D. B. Pisoni (Eds.), *Cognitive theory*, Vol. 1. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1975.

Rumelhart, D. E. Notes on a schema for stories. In D. G. Bobrow & A. M. Collins (Eds.), *Representation and understanding*. New York: Academic Press, 1975.

Rumelhart, D. E. Understanding and summarizing brief stories. In D. LaBerge & J. Samuels (Eds.), *Basic processes in reading: Perception and comprehension*. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Spiro, R. J. Inferential reconstruction in memory for connected discourse. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge*. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Stein, N. L. The effects of increasing temporal disorganization on children's memory for stories. Paper presented to the Psychonomic Society, St. Louis, 1976.

Stein, N. L., & Glenn, C. G. An analysis of story comprehension in elementary school children. In R. Freedle (Ed.), *Multidisciplinary perspectives in discourse comprehension*. Norwood, N.J.: Ablex, 1978, in press.

Thorndyke, P. W. Cognitive structures in comprehension and memory of narrative discourse. *Cognitive Psychology*, 1977, *9*, 77–110.

Worden, P. E. The development of the category–recall function under three retrieval conditions. *Child Development*, 1974, *45*, 1054–1059.