Remembrance of things parsed: Story structure and recall

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Remembrance of Things Parsed:
Story Structure and Recall

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An analysis of the underlying structure of simple stories is presented. It is claimed that this type of representation of stories is used to form schemata which guide encoding and retrieval. A type of tree structure containing basic units and their connections was found to be adequate to describe the structure of both single and multi-episode stories. The representation is outlined in the form of a grammar, consisting of rewrite rules defining the units and their relationships. Some transformational rules mapping underlying and surface structures are discussed. The adequacy of the analysis is first tested against Bartlett's protocols of "The War of the Ghosts." Then a developmental study of recall is presented. It is concluded that both children and adults are sensitive to the structure of stories, although some differences were found. Finally, it is suggested that the schemata used to guide encoding and recall are related but not identical and that retrieval is dependent on the schemata operative at the time of recall.

This report presents an analysis of the underlying structure of simple stories and examines the implications of such structure for recall. We use the term "story schema" to refer to an idealized internal representation of the parts of a typical story and the relationships among those parts. It is claimed that people use this type of representation of stories to guide comprehension during encoding and as a retrieval mechanism during recall. To be successful, the theory must provide a clear and unambiguous parsing system which can be used to divide a story into structurally important units. To be interesting, it should also be able to predict which of those units people will tend to remember and which they will tend to forget.

Bartlett's pioneering study of memory (1932) suggested that people develop schemata of what stories are like. His most important use of this notion was to indicate that it could account for some of the recon-

structive aspects of recall. He suggested that various omissions, distortions, and other changes in memory over time can be explained on the grounds that people use a story schema as a set of retrieval cues. When they cannot recall a particular aspect of a story, they can use the schema to reconstruct what might have occurred at that point. This general notion also accounts for the increasing regularization of irregular stories over time: Recall comes to approximate the idealized schema more than the actual form of the input.

However, the description of schemata in Bartlett's analysis necessarily remained very general because his theory did not account for the internal structure of stories; he used the term "schema" to include such notions as literary style, mood, and various classes of stories. Although these are important aspects of stories, which could be expected to affect retrieval, they seem less basic than a characterization of the units from which a story is constructed.

We will use the term "story schema" to refer to a set of expectations about the internal structure of stories which serves to facilitate both encoding and retrieval. People construct story schemata from two sources. One source comes from listening to many stories and consists of knowledge about the sequencing of events in stories, including how they typically begin and end. The other source comes from experience and includes knowledge about causal relations and various kinds of action sequences. However, the units which eventually form a story schema either condense or ignore many aspects of logical and experiential knowledge about the world. Only those perceptions, feelings, actions, and events which have to do with the ongoing plot or story line are represented in the schema, even though these may subsume other logical and psychological conditions.

During encoding, the schema acts as a general framework within which detailed comprehension processes take place. This framework performs several functions. First, it directs attention to certain aspects of the incoming material. For example, statements in the setting of a folktale (in contrast to the modern mystery story) are always relevant to later events; they warn the listener that certain facts should be kept in mind. Second, the framework helps the listener keep track of what has gone before. It provides a summary that increases the predictability of what will immediately follow. Third, the framework tells the listener when some part of the story is complete and can therefore be stored, or is incomplete and therefore must be held until more material has been encoded.

Although the schemata used to encode a story and to retrieve it are related, we do not assume that they are identical. Although the form in which information is processed influences the form in which it is retrieved (Tulving & Thomson, 1973), neither the amount encoded, nor even the

level at which incoming information is processed (Craik & Lockhart, 1972), is sufficient to predict recall of discourse. The material is all deeply processed and at present we have no way of determining whether some parts are deeper than others.

For example, a set of sentences, forming a story, which are all equally well comprehended (as tested by probe questions or cloze techniques) will not be equally well recalled a week or a month later. Recall will be, in part, a function of the role the sentences play in the overall structure of the story and the extent to which the story matches an ideal schema. The overall structure may not even be clear to the listener until after the telling has been completed, at which point reorganiza- tion in memory must occur. Reorganization continues to occur, as Bartlett has amply demonstrated, either over the course of time and/or at the time of later retrieval (cf. Spiro, in press). Therefore, a theory of story schemata designed to predict recall probably should stress the structural characteristics which are relatively invariant across stories rather than the more flexible structures available for use during the course of and immediately following input.

In attempting to uncover the details of story schemata, folktales, fables, and myths can be used to great advantage. Such stories, which stem from an oral tradition, have very similar and unusually clear structural characteristics compared to many other types of prose. The reason seems obvious. If a story is not written down but is preserved only through retelling, it must respect the limitations on memory. We assume that an orally transmitted story will survive only if it conforms to an ideal schema in the first place or has gradually attained such a structure through repeated retellings. Thus, the struc- ture of a folkstory must be one which has been influenced by what people can remember.[1]

Our analyses are based on Rumelhart's (1975) characterization of story structure.[2] Many of his notions about the constituent units making up a story are both intuitively plausible and theoretically elegant. It was seminal work because of its emphasis on global structures which specify suprasentential relationships and because it suggested useful ways to characterize such higher-order structure. However, our attempts to apply his analyses to new stories frequently failed. The structure de- scribed a very narrow range of stories, namely, those with single or embedded episodes. It also depended on a set of dual structures, one con-

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[1] Oral stories in their written form may be unusually schematic or even summarized versions of any given retelling. The schema only preserves the overall form of the story while allowing an individual narrator to elaborate details according to individual interests and purposes.

[2] Rumelhart (in press) has recently revised his grammar, and it varies in a number of ways from the 1975 version.

taining syntactic relations, the other semantic relations, which are unwieldy to work with and frequently redundant.

We have attempted to broaden the range of stories to which such analyses can be applied, while at the same time specifying the structures in enough detail that their use does not rest too heavily on the intuitive knowledge of the user. In addition, we have specified some of the relationships between hypothetical underlying structures of stories and their surface structures and thus have entered the realm of a story grammar.

It will be obvious that the grammar is far from complete. Our initial approach has been to derive generalizations about structure from traditional folktales. On the basis of our hypothesis about the relation between stories in the oral tradition and cognitive structures, these stories would seem to provide an appropriate data base for identifying the basic underlying forms from which alternative surface forms can be derived. Thus, there will be a continuous interchange in this report between description of the stories themselves and the story schemata which control memory.

The first section describes the grammar and uses it to parse four stories. Section II discusses the implications of this type of analysis for story schemata and their use in retrieval. Section III uses the grammar to parse Bartlett's classic story, "The War of the Ghosts," and examines its utility in describing the particulars of the recall protocols that Bartlett presented. Section IV discusses some developmental issues in the study of story recall and tests some of the predictions of Section II for children as well as adults.

I. A GRAMMAR OF SIMPLE STORIES

The grammar is designed to represent the structure of simple stories. A simple story is not defined by its length, number of events, or number of episodes, but by the fact that it has a single protagonist in each episode. The events in one episode may lead to another episode in which a different character becomes the protagonist, but within a given episode only one protagonist is allowed.[3] Although the grammar adequately describes the underlying structure of many folktales, fables, and myths, it has difficulty with conversational stories in which one character says something to another, who reacts and says something to the first character, etc. Such conversational stories lie outside the domain of the grammar because they assume at least two protagonists in any one episode, each with his or her own reactions. However, it can

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[3] A group of people may be represented as a single protagonist as long as their reactions and attempts are not differentiated. An example occurs in the King story (Table 3) in which three heroes act in concert.

handle a limited amount of conversation as long as the emphasis within any given episode is on a single character's reactions.

The underlying structure of a story can be represented as a tree structure which makes explicit the constituent structure and the relations between constituents. Events in the story are related both by their place in the tree structure, i.e., the type of node which they represent, and by between-node connections which may be either causal or temporal. The surface structure of a story consists of sentences. However, it may take several sentences, or only part of a sentence, to form a proposition which corresponds to a terminal node in the underlying tree.

Terminal Nodes

Although higher-level nodes are never directly expressed in a story, all terminal nodes represent either a STATE or an EVENT and typically correspond directly to some surface expression. A state may be external, i.e., a current condition of the world, or it may be internal, i.e., an emotion or state of mind. An event is any occurrence or happening and may also be external or internal. External events include actions of characters and changes of state in the world. Internal events include thoughts and plans, perceptions, and such peculiar phenomena as forgetting. The grammar in its present form does not classify states or events in more detail. However, since aspects of stories other than structure affect recall, we will occasionally discuss some special classes of states and events which occur frequently in stories and whose format may affect recall. For example, we have established a class of events called "apprisals" in which characters entering a story become aware of events which have already taken place. The important aspect of apprisals is not their status as internal events, but their redundancy with events that have already been expressed, which may cause them to be less well recalled.

Connections between Nodes

Nodes are connected by three types of relationship: AND, THEN, and CAUSE. There are some restrictions on privilege of occurrence of these three types of connection between various nodes which will be specified in the rewrite rules of the grammer. The AND relation connects two nodes when the notion of simultaneous activity or temporally overlapping states is being expressed. Two nodes which are temporally ordered are connected by THEN. It is possible to distinguish two types of THEN relations. In one, two events are temporally ordered but it is fortuitous which comes first; in the other, the ordering is determined by enabling relations (Schank, 1973a) or by expected sequences of action in the world. The latter connection is not reversi-

ble in the same way as the former. However, we have not found it necessary to differentiate these two types of THEN in the stories we have analyzed; in many cases the distinction cannot easily be made.

Two nodes are connected by the CAUSE relation when the first node provides a reason for the occurrence of the second. CAUSE does not have the restrictions associated with physical causation, wherein one event is both necessary and sufficient for another event to occur. Causal relations in stories have a looser character, implying sufficiency rather than necessity. However, CAUSE connects two nodes in a tighter, more integrated, structure than does either THEN or AND.

Several notational conventions in the rewrite rules should be mentioned. Items enclosed within parentheses represent optional expansions of a node. Parentheses marked with the superscripted index n indicate that the parenthetical item occurs one or more times. Brackets indicate mutually exclusive items; either may occur in that node, but only one kind may occur at a time.

EVENT* indicates that one terminal event is conjoined with one or more other terminal events within a single higher-level node. The node may also have appended an optional state. States can also be joined together to form a single node, STATE*. The rewrite rules are as follows:

$$\text{STATE*} \rightarrow \text{STATE ((AND STATE)}^n)$$

$$\text{EVENT*} \rightarrow \text{EVENT ((} \begin{Bmatrix} \text{AND} \\ \text{THEN} \\ \text{CAUSE} \end{Bmatrix} \text{EVENT)}^n) \text{ ((AND STATE)}^n)$$

These rules indicate that a node may consist of a single state or event, but that more than one can be combined in the ways indicated. These rules are more flexible than the other rules in the grammar because they must allow for the wide variety of ways in which terminal states and events can be gathered together into a single node. Because the grammar is primarily concerned with higher-level structures, we have not analyzed in detail the implications of these low-level connections. Eventually the relationships between terminal nodes within the next higher level (STATE* and EVENT*) must be developed, perhaps along the lines of the work of Schank (1973b) and Kintsch (1974) and integrated into the analysis of the higher-order structures.

Basic Nodes

The overall structure of a story is not represented by a list of terminal states and events nor by concatenating these terminal nodes into STATE* and EVENT*. The most important constituents of a story are "basic"

TABLE 1

SUMMARY OF REWRITE RULES FOR A SIMPLE STORY GRAMMAR[a]

FABLE → STORY AND MORAL

STORY → SETTING AND EVENT STRUCTURE

SETTING → $\left\{ \begin{array}{l} \text{STATE* (AND EVENT*)} \\ \text{EVENT*} \end{array} \right\}$

STATE* → STATE ((AND STATE)^n)

EVENT* → EVENT (($\left\{ \begin{array}{l} \text{AND} \\ \text{THEN} \\ \text{CAUSE} \end{array} \right\}$ EVENT)^n) ((AND STATE)^n)

EVENT STRUCTURE → EPISODE ((THEN EPISODE)^n)

EPISODE → BEGINNING CAUSE DEVELOPMENT CAUSE ENDING

BEGINNING → $\left\{ \begin{array}{l} \text{EVENT*} \\ \text{EPISODE} \end{array} \right\}$

DEVELOPMENT → $\left\{ \begin{array}{l} \text{SIMPLE REACTION CAUSE ACTION} \\ \text{COMPLEX REACTION CAUSE GOAL PATH} \end{array} \right\}$

SIMPLE REACTION → INTERNAL EVENT ((CAUSE INTERNAL EVENT)^n)

ACTION → EVENT

COMPLEX REACTION → SIMPLE REACTION CAUSE GOAL

GOAL → INTERNAL STATE

GOAL PATH → $\left\{ \begin{array}{l} \text{ATTEMPT CAUSE OUTCOME} \\ \text{GOAL PATH (CAUSE GOAL PATH)}^n \end{array} \right\}$

ATTEMPT → EVENT*

OUTCOME → $\left\{ \begin{array}{l} \text{EVENT*} \\ \text{EPISODE} \end{array} \right\}$

ENDING → $\left\{ \begin{array}{l} \text{EVENT* (AND EMPHASIS)} \\ \text{EMPHASIS} \\ \text{EPISODE} \end{array} \right\}$

EMPHASIS → STATE

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[a] See text for definitions of STATE and EVENT and for the connections AND, THEN, and CAUSE.

nodes, each of which subsumes one or more terminal nodes. Basic nodes can appear only in certain places in the tree structure and have more constraints on their format and connections than the lower-level nodes. The rewrite rules for these basic nodes are summarized in Table 1.

The first rewrite rule for a story is:

$$\text{STORY} \rightarrow \text{SETTING AND EVENT STRUCTURE}$$

Settings set the stage by introducing the protagonist and other characters. They also often include the time and locale of the story as well as information the listener needs to understand the events that follow. Thus, settings may consist of several states and events:

$$\text{SETTING} \rightarrow \begin{Bmatrix} \text{STATE* (AND EVENT*)} \\ \text{EVENT*} \end{Bmatrix}$$

It may be noted that this rewrite rule permits a loose structuring of states and events to occur within this node. In spite of this lack of internal structure, the setting frequently serves a formal function by signaling to the listener that certain types of event sequences will follow. "Once upon a time . . . ," for example, activates a story schema, arousing a different set of expectations than, for example, the first lines of a sonnet or a discussion on how to catch a fish (cf. Graesser, Note 1).

Although the grammar in its present form does not distinguish between various setting states, one type of setting statement is of crucial importance. We have not found any folktales which do not provide an introduction to a protagonist, no matter how brief. Such stories do not begin with the "The dog crossed the bridge . . . ," implying that the listener already knows who the protagonist is. This type of abrupt beginning seems to be reserved for stories originating in written form, where constraints on memory are less important and allow more luxury in format. Other types of setting states and events are optional. In short stories, stative information is usually confined to the setting node. In longer stories, this type of information may be postponed until it is relevant. It is for this reason that an optional state is appended to the rewrite rule for EVENT*.

The Dog story, which is shown in Table 2 and Fig. 1, can be used to illustrate the setting node and its place in the tree structure. The first proposition introduces the protagonist and the next two propositions specify the locale and other conditions which will be relevant to the event structure.

The setting is connected to the event structure by the AND connection, indicating that the conditions specified by the setting are in effect at the onset of the event structure. The event structure specifies

TABLE 2

Dog Story

1	It happened that a dog had got a piece of meat
2	and was carrying it home in his mouth.
3	Now on his way home he had to cross a plank lying across a stream.
4	As he crossed he looked down
5	and saw his own shadow reflected in the water beneath.
6	Thinking it was another dog with another piece of meat,
7	he made up his mind to have that also.
8	So he made a snap at the shadow,
9	but as he opened his mouth the piece of meat fell out,
10	dropped into the water,
11	and was never seen again.

the order in which episodes occur and will be discussed further after the parts of a single episode story have been outlined.

An episode consists of three causally connected nodes, all of which appear at the same level of the tree:

EPISODE → BEGINNING CAUSE DEVELOPMENT

CAUSE ENDING

The essential structure of a single episode story is that a protagonist is introduced in the setting; there follows an episode in which something happens, causing the protagonist to respond to it, which in turn brings about some event or state of affairs that ends the episode. The simplest story must have at least four propositions, representing a setting, beginning, development, and ending, if it is to be considered a story.

A beginning may consist of one or more events. In the Dog story, the beginning consists of an event which causes the dog to see something (propositions four and five). The crucial aspect of a beginning is that it causes the protagonist to respond in some way, forming the development.

BEGINNING → EVENT*

The development, as the term implies, is the most elaborated portion of an episode. The protagonist's response to the beginning is often complex and detailed. The first part of the development consists of an internal reaction which may be either simple or complex. The reaction, in turn, causes the protagonist to do something. A SIMPLE REACTION is followed by a single ACTION. A COMPLEX REACTION includes a GOAL and is followed by an ATTEMPT on the part of the protagonist to reach that goal.
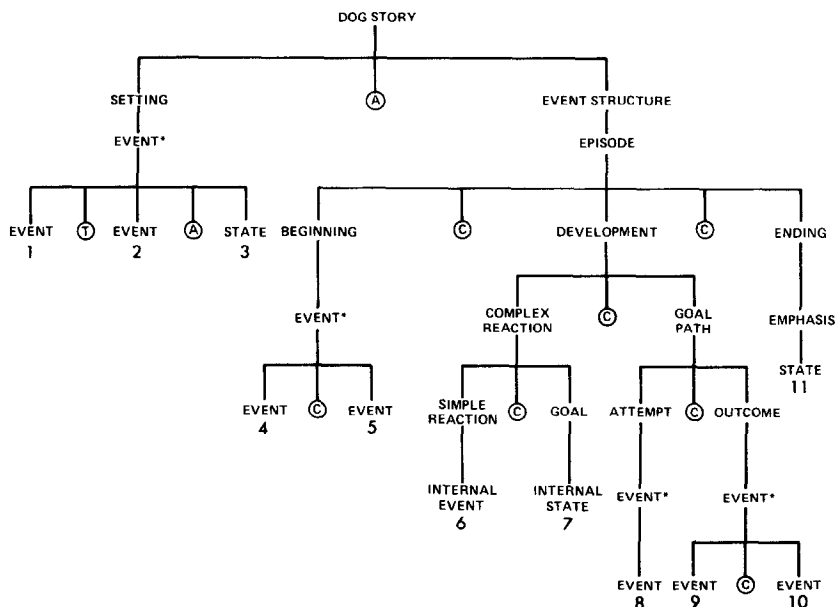
FIG. 1. A representation of the underlying structure of the Dog story. The connections AND, THEN, and CAUSE have been abbreviated to A, T, and C, and encircled. The numbers under the terminal nodes refer to the surface statements of the story.

$$\text{DEVELOPMENT} \rightarrow \begin{Bmatrix} \text{SIMPLE REACTION CAUSE ACTION} \\ \text{COMPLEX REACTION CAUSE GOAL PATH} \end{Bmatrix}$$

SIMPLE REACTION → INTERNAL EVENT
                              ((CAUSE INTERNAL EVENT)^n)

COMPLEX REACTION → SIMPLE REACTION CAUSE GOAL

The rewrite rule for DEVELOPMENT indicates that one of two types of sequences will follow the beginning. Characters sometimes respond in a relatively planless way, especially when the simple reaction consists of an emotion. In this case, the protagonist simply engages in an action rather than in an attempt to reach a goal. This is not to say that the behavior of the protagonist is unmotivated, but merely that his or her goal is irrelevant to the story line. We assume that all behavior in stories is motivated, and one can argue that a node labeled ACTION has some indirect goal. However, the grammar stresses only the basic nodes necessary for retrieval, and peripheral goals can be ignored. For example, in the first episode of the King story (see Table 3 and Fig. 2), the daughters enjoyed themselves so much that they forgot the time and stayed too long. Neither the

TABLE 3

KING STORY

1	There was once a king
2	who had three lovely daughters.
3	One day the three daughters went walking in the woods.
4	They were enjoying themselves so much
5	that they forgot the time
6	and stayed too long.
7	A dragon came
8	and kidnapped the three daughters.
9	As they were being dragged off they cried for help.
10	Three heroes heard the cries
11	and set off to rescue the daughters.
12	The heroes came
13	and fought the dragon,
14	and they killed the dragon
15	and rescued the maidens.
16	The heroes then returned the daughters safely to the palace.
17	When the king heard of the rescue
18	he rewarded the heroes.

surface nor underlying structure specifies a goal in this episode. The intention may have been to have a good time and perhaps also to be timely, but neither of these possible goals is necessary to understand the sequence. Even if a listener infers a goal in this sequence, as it becomes irrelevant to the overall structure, it will drop out of the schema being formed and will not be available later as a retrieval cue. This loss may be due in part to the simplified form of this type of development node which indicates to the listener that the particular sequence is unlikely to be critical to the overall story.

The more common type of development is a complex reaction followed by a goal path. A complex reaction consists of a simple reaction which in turn arouses a goal. In the Dog story, both occur, in propositions 6 and 7, respectively.

The surface structure of stories frequently omits both simple and complex reactions, leaving it to the listener to infer their nature from the surrounding context. That is, some reaction, either simple or complex, is assumed to exist in the underlying structure, although a well-formed story may allow its deletion. Even when reactions are stated in the surface structure they tend to be vaguely expressed. However, explicit statement of a goal lessens the listener's burden in structuring the story, since it can be inferred that a goal path is about to take place. When no goal is mentioned, the listener must analyze the following actions to determine if in fact a relevant goal exists in the underlying structure.
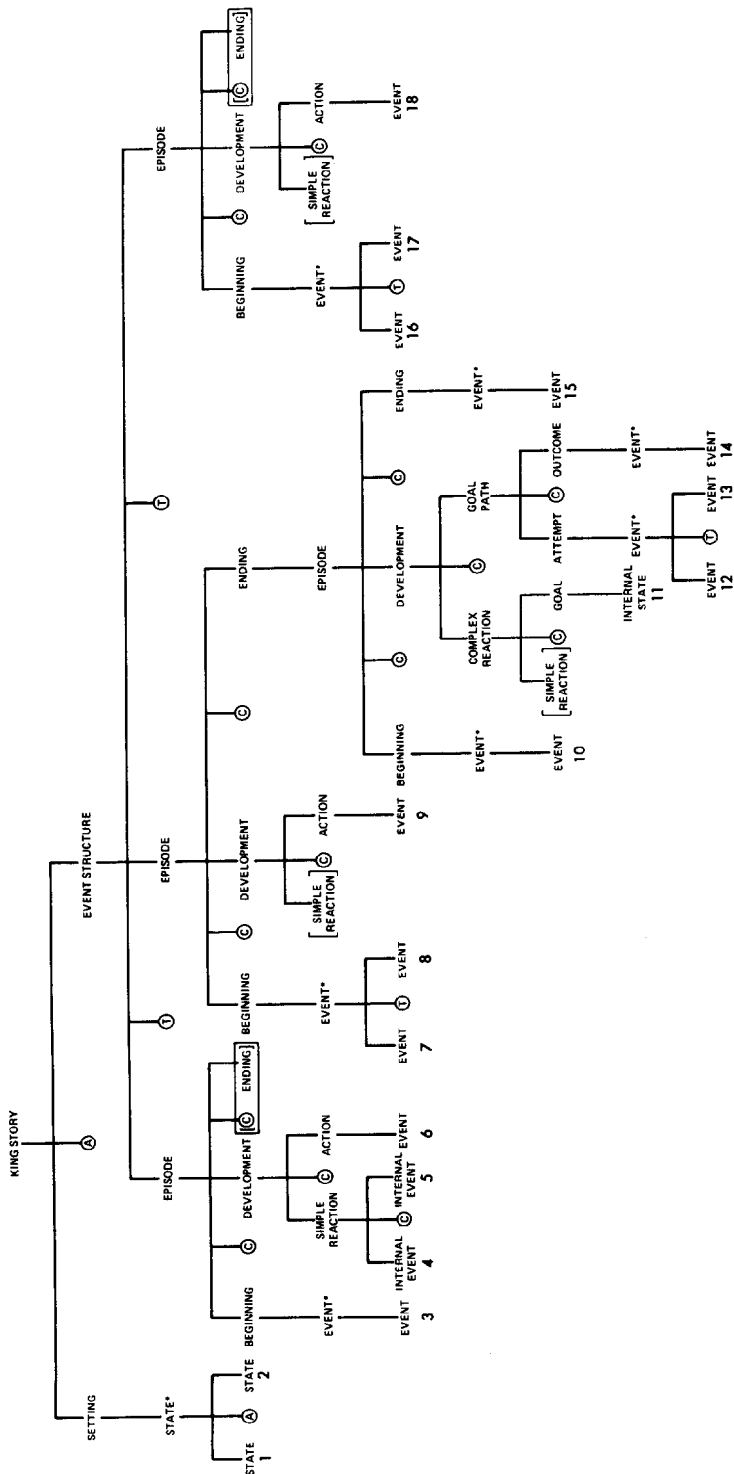
FIG. 2. The underlying structure of the King story. Underlying nodes which have been deleted from the surface structure are enclosed in brackets. Violations of canonical structure are enclosed in boxes.

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A GOAL PATH consists of two parts, an ATTEMPT and an OUTCOME.

$$\text{GOAL PATH} \rightarrow \left\{ \begin{array}{l} \text{ATTEMPT CAUSE OUTCOME} \\ \text{GOAL PATH (CAUSE GOAL PATH)}^n \end{array} \right\}$$

The protagonist tries to find some way to realize the goal. If the outcome is not successful, the episode may come to a close, but frequently the protagonist tries again. That is, goal paths are recursive and any number of attempts to achieve the same goal may occur. However, if the protagonist changes the goal, a new episode begins. This type of structure is discussed below. In the Dog Story, there is only a single goal path; proposition 8 is an attempt and propositions 9 and 10 express the outcome.

A goal path sometimes consists of a verbal exchange, in the form of an argument by the protagonist and a reply on the part of another character. We have not found it necessary to distinguish between verbal and nonverbal actions. However, whenever characters talk as well as act there is the possibility of redundancy and overlap between propositions. As mentioned earlier for apprisals, such redundancy may affect recall. Arguments, consisting of statements and replies, allow primitive conversations into stories. They are primitive in the sense discussed earlier; the emphasis is on the protagonist and the protagonist's goal. Such conversation is one-sided and ignores the intentions and goals of the replier.

$$\text{ATTEMPT} \rightarrow \text{EVENT*}$$

$$\text{OUTCOME} \rightarrow \text{EVENT*}$$

Finally, we come to the closing of an episode or of a story, the ENDING. In a simple story in which there is a single goal path, there may be considerable redundancy between an outcome and an ending. Nevertheless, the distinction is important and in most episodes is clear. An outcome is a local consequence, the immediate result of the particular attempt carried out; its causal connection to the attempt is straightforward. The ending tends to be connected to the development as a whole rather than to the immediately preceding event. Endings may refer back to the beginning, the protagonist's reaction, or the attempt. In the first episode of the Boy story (see Table 4 and Fig. 3), for example, the boy's attempt to carry the cake carefully fails. The ending of the episode consists of a lecture from his grandmother on how the attempt should have been carried out.

The ending is a most interesting aspect of stories because it is not intuitively obvious that all stories should have an ending in addition to an outcome. If a story consists of a problem-solving situation in which a series

TABLE 4

BOY STORY

1	Once there was a little boy
2	who lived in a very hot country.
3	One day his mother told him to take some cake to his grandmother who lived nearby.
4	She warned him to hold it very carefully so it would not break into crumbs.
5	The little boy wrapped the cake up in a leaf,
6	tucked it under his arm,
7	and carried it to his grandmother's house.
8	When he got there the cake had all crumbled into pieces.
9	His grandmother told him he was a silly little boy,
10	and that he should have carried the cake on top of his head so that it wouldn't break.
11	Then she gave him a pat of butter to take back to his mother's house.
12	The little boy wanted to be very careful with the butter,
13	so he put it on his head
14	and carried it home.
15	The sun was hot
16	and when he got home the butter had all melted.
17	His mother told him he was a silly little boy,
18	and that he should have wrapped the butter in a leaf so it would have gotten home safe and sound.

of attempts occur, a final resolution of the problem can be expected (cf. Thorndyke, 1975). However, even the simplest well-formed story will have an ending. Frequently it "wraps up" the story. The last episode of the King story is not well formed since it lacks an ending and thus concludes the story in an abrupt fashion. This may have been what prompted one of our adult subjects to finish her recall by remarking, "And I don't remember if they lived happily ever after or not." Such a statement is the type of ending which we term EMPHASIS. An emphatic ending truly wraps up the story with a dramatic flourish, sometimes emphasizing lifetime results of the previous events.[4] An example of EMPHASIS is the last proposition of the Dog story.

$$\text{ENDING} \rightarrow \left\{ \begin{array}{l} \text{EVENT* (AND EMPHASIS)} \\ \text{EMPHASIS} \end{array} \right\}$$

An emphatic ending often has the flavor of a moral. Its occurrence in even simple stories suggests the affinity of story to myth and fable. The grammar can be expanded to describe the structure of myths and

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[4] Such emphatic endings may occur only in single episode stories or at the ending of the final episode in a multi-episode story; however, the grammar does not restrict their occurrence in this way.
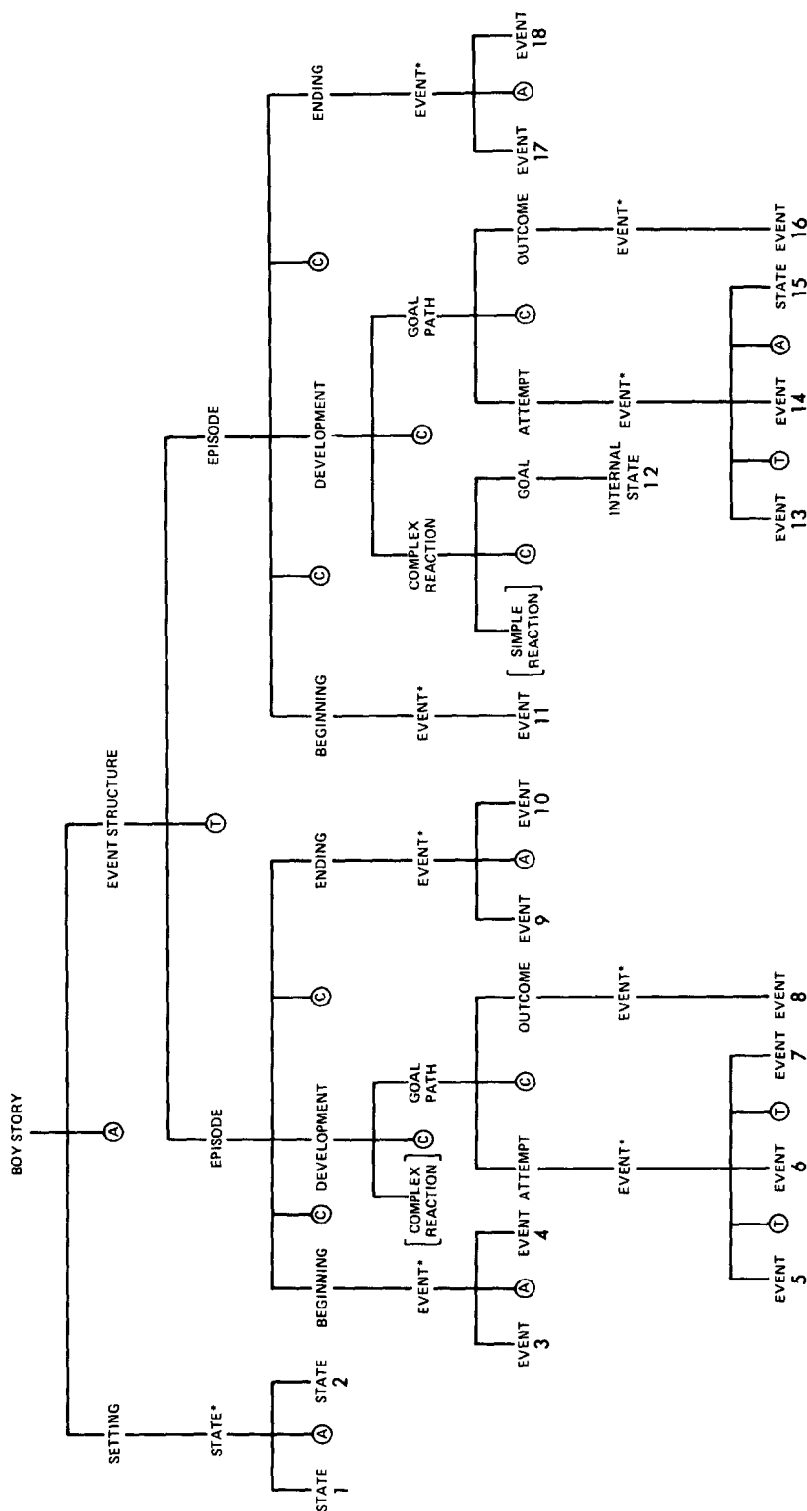
FIG. 3. The underlying structure of the Boy story.

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fables. For example, a fable consists of a story with an appended moral:

<div align="center">FABLE → STORY AND MORAL</div>

Before leaving the discussion of the structure of an episode, it should be noted that our tripartite division into a beginning, development, and ending, all of which occur at the same level in the tree structure, may ignore some genuine hierarchical relations among these three nodes. For example, the development may be more tightly connected to the beginning than to the ending. Since this possibility is a rather subtle structural distinction, involving further differentiation of the CAUSE relation, it is perhaps better left to future development of the grammar.

Connections between Episodes

We have left the specification of EVENT STRUCTURE until the internal structure of single episodes was described. Episodes are connected in the following way at the level defined by the event structure node:

<div align="center">EVENT STRUCTURE → EPISODE ((THEN EPISODE)^n)</div>

This specification of the event structure indicates that a story must have at least one episode, but it need not have more than one. Although only the THEN relation can connect episodes at this level of the tree, we will see that episodes may be causally connected through expansions of the rules which define certain basic nodes. The THEN connection has the same sense as discussed earlier for connections between propositions. Two examples of temporally connected episodes are found in the King story. After the heroes rescue the maidens they return them to the palace and the king reenters the story. Now it is true that the heroes could not return the daughters if they had not encountered them in the first place, but neither is the connection causal. The question, "Why or how did the heroes return the daughters?" is not answered by the fact that they rescued them from the dragon. Similarly, the daughters might not have been kidnapped if they had not been in the woods, but unless one interprets this story as a morality play in which "staying out too late" causes bad things to happen (and it is possible for a listener to make this assumption), the connection between staying out and being kidnapped has some of the fortuitous character typical of temporally connected events. The THEN connection between episodes marks one of the areas of ambiguity in story comprehension; one listener may accept a temporal connection, whereas another may seek a causal explanation.

Another example of a story with THEN-connected episodes is the Boy

TABLE 5

FARMER STORY (SHORTENED VERSION)

1	Once there was an old farmer
2	who owned a very stubborn donkey.
3	One evening, the farmer wanted to put his donkey into the barn.
4	First he pushed him,
5	but the donkey would not move.
6	Then he pulled him,
7	but the donkey still would not move.
8	Next the farmer thought he could frighten the donkey into the barn.
9	So he asked his dog to bark at the donkey,
10	but the lazy animal refused.
11	Then the farmer thought that his cat could get the dog to bark.
12	So he asked the cat to scratch the dog.
13	The cooperative cat scratched the dog.
14	The dog immediately began to bark.
15	The barking so frightened the donkey
16	that he jumped into the barn.

story. The two episodes are structurally independent; i.e., each episode, by itself, has a complete set of basic nodes that immediately dominate terminal nodes (or EVENT*). Although a listener may infer that events in the second episode have been influenced by events from the first, this relationship is carried by the content of separate terminal nodes in the two episodes rather than by the structure of the story.[5]

Episodes are causally connected by one of three types of embedding. The first type of causal connection is an ending-embedding. The development of one episode may cause an ending which itself consists of a new episode; i.e., an ending may be rewritten as an episode. The third episode of the King story illustrates this type of embedding. The ending of the episode in which the princesses are kidnapped and cry for help is that the heroes come and rescue them; the rescue has episodic form but with a new protagonist.

The second type, a beginning-embedding, occurs when an entire episode forms the beginning of a second episode. That is, a series of events which themselves form an episode constitute the stimulus to the development of a further episode. The third type of causal connection, outcome-embedding, is illustrated in the Farmer story (see Table 5 and Fig. 4).[6] This type of story involves a series of unsuccessful goal paths. Each outcome induces the protagonist to form a subgoal in the service of the larger goal represented in the higher-level episode. The farmer's goal is to get his

[5] In an earlier version of the grammar (Mandler, Johnson, & DeForest, Note 3) we attempted a causal interpretation.

[6] This story is a shortened version of one written by Rumelhart to represent a common type of embedded episode story which was also used by Thorndyke (1975).

FIG. 4. A simplified representation of the Farmer story. Nodes below EVENT*
are not included.

donkey into the barn. When his first two goal paths fail, he develops a
subgoal, which is to frighten the donkey. When unable to achieve that
subgoal, he develops still another subgoal, etc. All of these goals are
subordinate to the main goal, but each change in goal forms a new
episode whose beginning is the unsuccessful outcome of the previous
attempt. When one of the subgoals is finally achieved, this type of story
typically has a series of statements occurring in sequence which provide
endings for each of the outcome-embedded episodes.

Event structures, then, can result in several types of tree. If episodes are connected by THEN, they all appear on the same level. If episodes are causally connected, they appear as a rewriting of either a beginning, an outcome, or an ending. Because causally connected episodes are all embedded within larger episodes, they form more tightly integrated structures than THEN-connected episodes. Thus, if the event structure is rewritten into a single higher-level episode, as in the Farmer story, the overall structure of the story is more tightly knit than if the event structure node branches into two or more THEN-connected episodes, such as the King and Boy stories.

Finally, slightly more elaborate stories can have a partial episode embedded under a constituent node of another episode. We call these partial episodes SUBEPISODES. They continue the episodic structure from the node which is subdivided. This type of structure is apt to be found when a story has more than one protagonist within an episode and thus moves out of our classification of a simple story. Nevertheless, it is instructive to indicate how the grammar can be expanded to include somewhat more complex stories. An example would be a story in which a beginning causes two developments. One protagonist reacts and carries out a goal path, followed in turn by the second protagonist's reaction and goal path. These two subepisodes would then be followed by a single ending.[7] An example of this type of structure would be the case in which the beginning consists of a competitive situation between two protagonists. They go off to do their own things, and the story ends by telling who won the competition. The overall structure consists of a single setting and beginning, two developments, and a single ending. Whether or not more elaborate stories will be satisfactorily described by similar extensions of the grammar remains to be seen.

Transformational Rules

For the most part, the four stories we have discussed have underlying structures which are realized in canonical surface structures. Almost every node in the underlying structures is represented by a statement in the surface structure appearing in the correct sequential order. However, the surface realizations of stories may be more or less ideal. For example, the surface structure may express all of the basic nodes, but the order in which they occur may not match the underlying structure. In this case, the numbers representing the surface propositions would be out of order in the tree diagram. Unless we assume that only those stories which do not deviate at all from the proposed underlying structures are well formed,

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[7] Such structures have been generally described by Propp (1968) as one of the forms found in Russian folktales.

we will have to specify which transformations of the underlying struc-
ture are permissible and which are not.

If we had an independent definition of a well-formed story, the search
for transformational rules would be easier. Lacking such a definition, we
could proceed as linguists often have and ask people whether a given piece
of prose is or is not a story. This technique has problems, even for the
definition of a sentence (cf. Gleitman & Gleitman, 1970), and the problem
may be even more severe for stories. People are able to categorize
prose passages crudely as stories or nonstories, or even as good or bad
stories, but the finer details of story structure are too complex to be
amenable to such intuitive judgments. Instead, we have proposed to
make our initial tests of well-formedness and the transformational
rules relating well-formed stories to underlying structures on the basis of
what people can and cannot remember and on the nature of the dis-
tortions that occur in memory.

Our examination of stories has suggested two major types of trans-
formational rules, those governing deletions and reorderings of nodes.
We have only begun to explore these transformations and have not yet
formalized them. One kind of deletion rule has already been suggested;
it allows any kind of reaction to be omitted from the surface struc-
ture without destroying the well-formedness of the story. If we use recall as
a test of this hypothesis, it would be tantamount to predicting that a
story will always be equally well recalled whether a reaction is present in
the surface or not. Such an outcome seems unlikely. Whenever a node is
missing from the surface, the possibility of misinterpretation arises,
increasing the likelihood of distortion in comprehension or recall. What
must be done is to specify the degree of difficulty the omission
of a reaction is likely to cause. A simple reaction or goal, even when
stated, is often so obvious that it is only vaguely expressed in the
surface realization; such an omission would not be serious. However,
if the underlying reaction or goal is ambiguous or counter to our ex-
pectations about the world, its omission would lead to a violation. It is
this kind of omission which makes a well-formed story from one culture
appear ill-formed to another. A goal path may be clearly motivated for
one audience whether the goal is stated or not because it fits a cultural
stereotype; that same goal path may be utterly mysterious to another group
without specific statement of the underlying goal. Thus, some qualification
of permissible reaction-deletions probably will have to be made.

We have found only one other type of basic node that may be de-
leted. It is permissible to delete beginnings under two circumstances. In
some folktales, the beginning of the first episode is omitted and it starts in-
stead with a statement of the protagonist's complex reaction. Our
version of the Farmer story is of this type; the first episode begins with

the farmer wanting to get his donkey into the barn, followed by his attempts to achieve this goal. Propp has characterized this situation by noting that stories sometimes begin with expression of a "lack" felt by the protagonist which often precedes a quest. In any case, the reaction is not explicitly motivated by prior events and appears to be self-generated.

The other type of beginning-deletion occurs when a character who has already appeeared in the first episode becomes the protagonist of an ending-embedded episode. The first statement in the ending-embedded episode is the new protagonist's reaction to the immediately preceding events. The deleted beginning is a type of apprisal, implying that the new protagonist saw what was happening, but since it is redundant with these events it may be omitted.

The most interesting aspect of these beginning-deletion rules is their relation to the deletion of reactions. If the reaction has been deleted, the beginning may not be, and vice versa. More specific dependency relations between these two types of deletion remain to be explored.

At present, the grammar states that all other deletions of basic nodes result in violations of ideal story structure. For example, the two omissions of endings in the first and last episodes of the King story result in a less than ideal story and predict consequent distortions in recall.[8]

Although basic nodes, with the exceptions just mentioned, cannot be deleted, a canonical story need not specify the causal connections between nodes in the surface structure; these are automatically supplied by the listener. When propositions are out of order, however, the causal relations between the moved nodes *must* be explicitly stated if the correct underlying structure is to be recovered by the listener. We have little information at present about which reorderings of basic nodes, even when marked with appropriate causal relations, will be violations of underlying structure rather than permissible transformations.

Some sequence inversions can be quite "distant" without disrupting the structure of basic nodes, such as presenting the ending of a story first, with the events leading up to it presented as a "flashback." This type of displacement will not necessarily interfere with comprehension if its occurrence is well marked. However, even when marked, such a displacement should result in poorer recall than if the ideal sequence had been followed in the surface structure. Other surface displacements may actually violate restrictions on transformations of the underlying structure, thus leading either to a change in the perceived

[8] The King story is a summary of an old Russian folktale which does not end in the abrupt fashion of the present version (Propp, 1968).

meaning of the story or to a failure to recover a coherent underlying structure.

II. SOME IMPLICATIONS OF STORY STRUCTURE FOR RECALL

We have described an ideal structure of simple stories. As noted in the introduction, we believe that people use story schemata, based on such structures, to guide encoding and retrieval processes. Although both encoding and retrieval involve selection and construction, these processes do not produce identical results. First, more will be encoded than will be recalled. The use of probe questions following recall typically produces more of the story than was spontaneously retrieved.

Second, the effects of story schemata will be more apparent during retrieval than during encoding. A story with poor structure, in the sense that nodes are omitted or causal connections are replaced by temporal ones, may be reasonably well comprehended and recalled if tested soon after presentation. A story may also contain departures from the expected order of propositions. If these sequence inversions are clearly marked in the surface structure, the story may be well comprehended and well recalled for a time. However, the longer the delay between telling and recall, the more recall will come to approximate an ideal schema instead of the actual story heard.

Third, importations of new material into recall which fill the structural requirements of a given node may be only loosely related to the initial encoding process. For example, one adult recall protocol of the Dog story followed the actual story line quite accurately until the last proposition. After recalling that the meat fell into the river, she went on to say, ''And the dog lost his balance and fell over and that was the end of the dog.'' This kind of addition is not merely fanciful; it is an attempt to provide an emphatic ending. The content is gone but the structure is still there and requires some output.

These general considerations, in conjunction with the details of story structure outlined in the last section, suggest a number of specific predictions about successes and failures in recall. These are discussed below, grouped under four headings: overall extent and accuracy of recall; likelihood and accuracy of recall of different parts of a story; sequence inversions in output; distortions and additions.

1. Overall Accuracy and Extent of Recall

In general, the more a story conforms to an ideal structure, the better recall will be.

1a. A story whose surface structure contains all the basic nodes of an ideal structure will be more accurately and extensively recalled than a story which lacks one or more nodes.

1b. The more the sequence of sentences in the surface structure follows the sequence of an ideal structure, the better recall will be. The magnitude of this effect will be a function of three factors: (1) the extent to which a given sequence of propositions differs from the expected sequence, both in terms of the number of deviations and the distance of given propositions from their expected locations; (2) whether or not sequential displacements are appropriately marked in the surface structure so that the correct underlying structure can be recovered; and (3) the extent to which a displacement interrupts the internal structure of basic nodes, e.g., whether an ending is simply moved to a position preceding the beginning or to a position in the middle of a complex reaction.

2. Likelihood and Accuracy of Recall of Parts of a Story

The basic node is the main unit of recall.

2a. Elaboration of nodes will be poorly recalled. Many words, even whole clauses, are merely elaboration of the basic nodal structure. Nodes may contain clauses explaining how or why something is being done, or temporal bridges, such as "When he got home. . . ." These, in addition to other elaborations, including descriptive adjectives and adverbs of all sorts, will be less well recalled than the phrases conveying the structural meaning of a node.

2b. Nodes which are optionally deletable from the surface structure will be less well recalled than other basic nodes. Reactions, therefore, will be less well recalled than settings, beginnings, etc., and the deletable beginnings discussed earlier will be less well recalled than other beginnings.

2c. Causally connected episodes will be better recalled than temporally connected episodes. The rewrite rule for EPISODE unites causally connected episodes into single large episodes, whereas temporally connected episodes remain separate.

2d. The recall of a given state or event will be a function of the type of node or episode in which it occurs. This generalization follows from 2a through 2c. Since the underlying structure determines recall, the same surface sentence should be differentially recalled, depending on the recallability of the node or episode in which it is placed.

3. Inversions of Sequence

In general, inversions in recall are a function of violations in sequencing of propositions in the surface structure of a story.

3a. A story with an ideal structure will produce few if any inversions in the order of recall of nodes. A story with nodes presented in other than the ideal order will increase the number of inversions; i.e., a displaced node, if recalled, will tend to appear in its correct place

in the ideal structure. This prediction is similar to 1b and the same arguments apply. The difference is that in this case sequencing, rather than accuracy, is at issue.

3b. Inversions of phrases within a proposition and inversions between terminal nodes within a basic node will be more frequent than inversions between basic nodes. This prediction again stems from the assumption that the main unit of recall is the basic node. The sequence of basic nodes is invariant in the ideal structure; thus, if the surface story follows the ideal structure, temporal ordering of nodes will be respected in recall.

Within basic nodes, recall is probably determined by the nature of the connections. We would expect causally connected propositions to be recalled in correct sequence more often than those with simultaneous or simple temporal connections. However, this prediction is simply a generalization from the underlying notion of the grammar that a story primarily consists of causally connected parts.

4. Additions and Distortions

4a. Additions of new material into recall will supply basic nodes either missing from the surface structure of the story or whose content is not retrievable. Since reactions are optional in the surface structure, a predictable kind of addition is one which supplies missing reactions. When the correct content of a nonoptional node is not retrievable, we should expect additions which express the structural requirement of the node.

4b. Distortions in recall will occur at points where ambiguity or violation of an ideal structure occurs in the surface structure. This prediction is similar to 1a and 1b except that it predicts specific distortions at, or around, the point of violation.

Support for some of these predictions has already been provided by Thorndyke (1975). Using a grammar related to Rumelhart's, he varied the structure of two stories and studied recall and ratings of comprehensibility. When the "theme" of a story was moved from its normal place to the end, both measures suffered. His definition of "theme" is complex and difficult to translate into our terminology; the displacements involved both goals and outcomes and seem to have removed many of the causal connections between the remaining propositions. Nevertheless, his findings support prediction 1b, that recall is better when the sequence of propositions in the surface structure follows the ideal structure. He also found that when the theme propositions were omitted altogether, recall was even worse and ratings of comprehensibility were even lower (prediction 1a). In addition, inversions of sequence occurred in recall of disarranged stories, with the theme moving closer to its normal place in the story (prediction 3a).

Informal support for other predictions comes from Kintsch (Note 2) and Propp (1968). Kintsch contrasted two stories, one of which appears to have consisted only of causally connected episodes, while the other contained at least one "arbitrarily" connected episode. Although recall was not studied, subjects found the causally connected story easier to summarize and gave higher ratings of importance to its units (prediction 2c). Propp reports that narrators of long fairy tales sometimes lose track of the story they are telling and fill in later parts with incorrect, although presumably structurally consistent, content (4a).

The experiment reported in Section IV, which used four "natural" folktales, was able to test many, although not all, of the predictions outlined above. Using natural stories, one is limited by the kinds of structures and frequency of occurrence of particular constructions which they happen to provide. An adequate test of all of the predictions discussed here will require extensive research and, in particular, will require the construction of ideal stories whose structure is unambiguous and which can be systematically manipulated.

Before presenting the results of the recall experiment, we shall see how well the grammar handles that classic and often-recalled tale, "The War of the Ghosts." Many studies have been devoted to this tale, but few have been able to explain in detail why recall is so poor or why distortions occur where they do.

III. THE STRUCTURE OF "THE WAR OF THE GHOSTS"

Analyzing "The War of the Ghosts" should be an instructive exercise because, if Bartlett is correct, it is an ill-formed story in which some of the incidents have no obvious causal connections and lack a rational order. If this story is indeed an old folktale, its irregularity would be somewhat embarrassing for the hypothesis that a folktale can only survive in an oral tradition if it has a memorable structure. Fortunately, its provenance is obscure. Bartlett took the story from an article by Boas (1901) who reports two versions of it, each of which is somewhat more sensible than Bartlett's version. We also assume that some of its obscurity derives from conventions familiar to its intended audience but foreign to our culture.

Analyzing such an irregular story makes for a rough maiden voyage. Nevertheless, the grammar should be able to identify the most obvious violations of structure and, ideally, should predict some of the characteristics of recall that Bartlett found. To the extent that the grammar predicts (or in this case, postdicts) areas of difficulty in recall, its utility will have been demonstrated.

Our division of the story into propositions is given in Table 6 and a condensed version of the underlying structure, showing only basic nodes, is illustrated in Fig. 5. Obvious violations among nodes have been

TABLE 6

THE WAR OF THE GHOSTS

|	
1	One night two young men from Egulac went down to the river to hunt seals,
2	and while they were there it became foggy and calm.
3	Then they heard war cries,
4	and they thought, "Maybe this is a war party."
5	They escaped to the shore
6	and hid behind a log.
7	Now canoes came up,
8	and they heard the noise of paddles
9	and saw one canoe coming up to them.
10	There were five men in the canoe,
11	and they said, "What do you think? We wish to take you along.
12	We are going up the river to make war on the people."
13	One of the young men said, "I have no arrows."
14	"Arrows are in the canoe," they said.
15	"I will not go along.
16	I might be killed.
17	My relatives do not know where I have gone.
18	But you, " he said, turning to the other, "may go with them."
19	So one of the young men went,
20	but the other returned home.
21	And the warriors went on up the river to a town on the other side of Kalama.
22	The people came down to the water,
23	and they began to fight,
24	and many were killed.
25	But presently the young man heard one of the warriors say, "Quick, let us go home; that Indian has been hit."
26	Now he thought, "Oh, they are ghosts."
27	He did not feel sick,
28	but they said he had been shot.
29	So the canoes went back to Egulac,
30	and the young man went ashore to his house and made a fire.
31	And he told everybody and said, "Behold, I accompanied the ghosts, and we went to a fight.
32	Many of our fellows were killed,
33	and many of those who attacked us were killed.
34	And they said I was hit
35	and I did not feel sick."
36	He told it all,
37	and then he became quiet.
38	When the sun rose he fell down.
39	Something black came out of his mouth.
40	His face became contorted.
41	The people jumped up and cried.
42	He was dead.
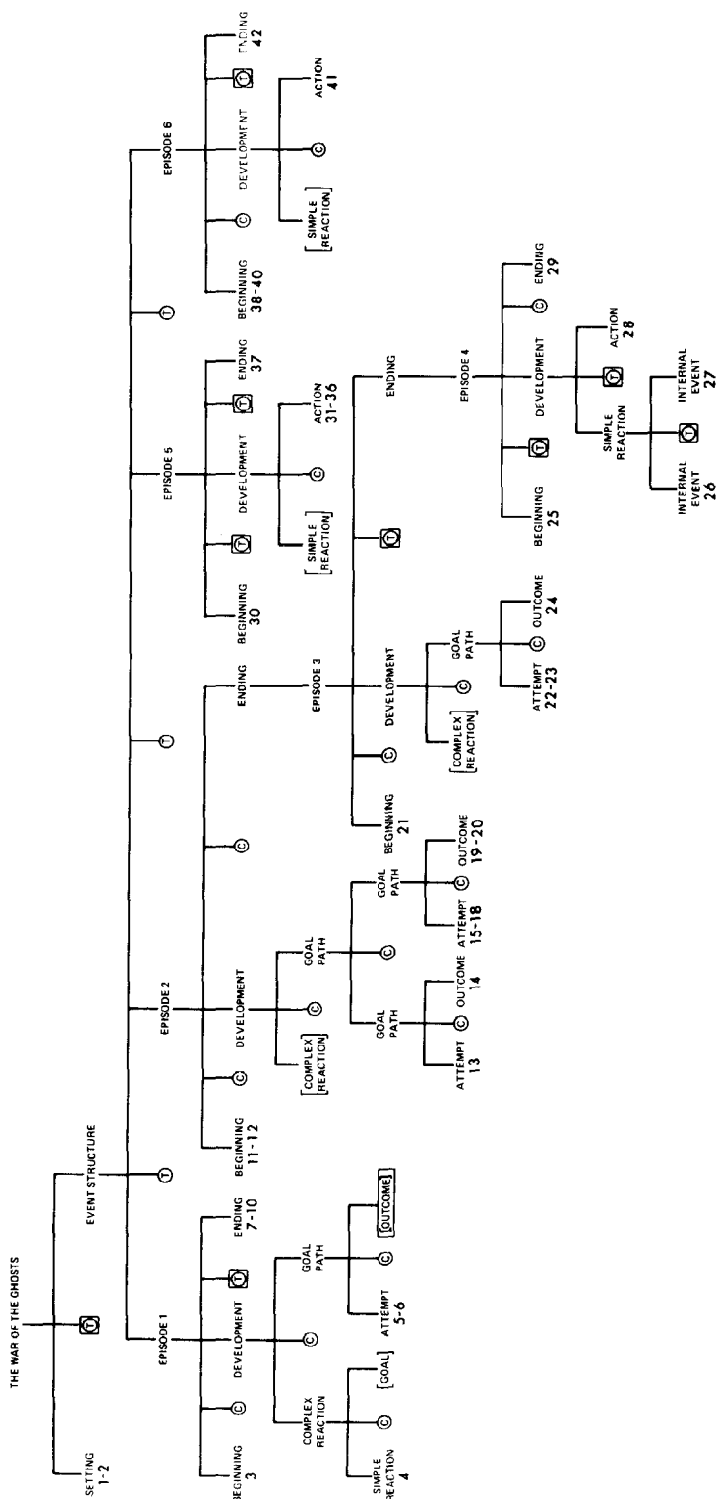
FIG. 5. A simplified representation of the War of the Ghosts story. Only basic nodes are shown. Violations are enclosed in boxes.

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enclosed in boxes. The representation is only one of several possible interpretations and may ascribe more structure than most listeners would be able to infer. Such indeterminate parsing is probably a characteristic of ill-formed stories.

Inspection of Fig. 5 indicates that a predominant characteristic of this story, at least in Bartlett's translation, is the presence of temporal relations where causal ones are expected. Most of the marked violations consist of THEN connections where CAUSE connections are required by the grammar. This should loosen the structure of the story and produce inversions and distortions in recall.

The story consists of six episodes, five of which are THEN-connected. This type of event structure, above and beyond any violations, should be difficult to recall (cf. Kintsch, Note 2). In the first episode, the outcome is omitted and the development is connected temporally to the ending. In the second episode, the sequence of attempts and outcomes is haphazard and the causal connections between them are obscure. The attempt in the second goal path lists four events and it is not clear why the outcome should follow one rather than another. We have not marked a violation between the second attempt and its outcome, but the CAUSE relation between the two is an optimistic interpretation.

The most serious violations occur in the fourth episode. First, there is a violation at propositions 26 and 27 in which two internal events are connected by THEN instead of CAUSE. This violation is important because a sequence of thoughts, vital for further understanding of the story, is disconnected, and the listener is likely to lose the thread of the story. It might be noted that this severance of causal connections occurs at the first mention of ghosts (other than in the title) and thus is responsible for the ambiguity of their role in the story. They are arbitrarily inserted in a sequence of events. A listener might make the causal inference that because the protagonist did not feel sick he decided the people who said he had been shot must be ghosts; however, this interpretation is apparently infrequent.

The violation within the reaction is followed closely by another major violation, namely, that the internal response of the protagonist is followed by an action on the part of others (proposition 28). The relation between the reaction and the following action is not CAUSE but, once again, THEN. This change of protagonist in the middle of an episode is a fundamental violation of structure.

Beginning with the ending of the fourth episode, the story rapidly deteriorates. A rough summary of the last 13 propositions would be that the young man goes home, tells the people what has happened, gets sick, and dies. This overall sequence is sensible enough, but there is little structure, as we have defined it, holding the individual items together. Our optimistic parsing of the last two episodes required serious deliberation. It seems doubtful that this structure would be apparent on first reading. At best, one would expect the sequence of events in the

overall summary just described to be maintained, but within those four parts sequential inversions should occur.

The fifth episode contains an unusual feature: The protagonist retells events which have just taken place (propositions 31 to 36). This is the only story we have seen in which so much redundancy between action and verbalization occurs. More typically, these propositions would be expressed by stating, "And he told them what had happened." This redundancy gives the recaller a choice, either to output the events and summarize their retelling, or vice versa. The former should be more likely because the actual events occur earlier in the story and because events have more certainty than a character's account of them. It should be noted that the grammar has not been designed to account for this kind of anaphoric reference.

Finally, the last five propositions of the story, although seeming to have a kind of episodic structure, are held together primarily by THEN relations and either must be considered as violations or as having no true story structure at all. In either case, these propositions should be characterized by sequence inversions during recall.

Bartlett provided six protocols which represent initial reproductions of the story. Analysis of the repeated reproductions, which form the majority of protocols he reported, would not be useful for our present purposes, since each successive reproduction is determined more by the revised structure produced during the previous recall than by the story as originally heard. Analysis of the first-recall protocols revealed the following findings relevant to the predictions from the grammar.

There were six propositions which almost no one recalled. Five of these occurred next to a violation and the sixth occurred in one of the unconnected strings of events. Proposition 2 was followed by a minor violation in the connection of the setting to the event structure. It is possible that the poor recall of this proposition was also due to its status as an optional setting proposition. The two attempts in the first episode which had no outcome (propositions 5 and 6) were poorly recalled, as was the action in the fourth episode which is carried out by other characters instead of by the protagonist (proposition 28). The beginning of the fifth episode which is unrelated to the following development (proposition 30) tended to be omitted, as well as one of the events in the disconnected goal path in the second episode (proposition 16).

Five of the six subjects inverted at least two basic nodes and the sixth subject (whose recall was unusually complete) made one. These figures are markedly higher than the data from well-structured stories reported in the next section. All but one of these sequence inversions occurred in the unstructured goal path in the second episode, at the violation in the reaction in the fourth episode, and in the unstructured series of events in the last episode. Distortions in content also occurred most frequently at these points.

The mean proportion of propositions recalled from the causally connected episodes was .61, whereas the proportion from the temporally connected episodes was .48. Recall of elaboration of nodes was poor, as Bartlett also reported. Finally, there was almost no overlap between recall of the events of the fight and the retelling of those events.

The usefulness of the grammar seems evident when contrasted with Bartlett's analyses. Many of his points are difficult to generalize to other stories. Because he had no overall representation of the structure of stories, his analyses of omissions, distortions, and sequence inversions, have an ad hoc character. When inversions were found in the recall protocols, after the fact he could say that these propositions were of "unusual interest." In general, his hypothesis of unusually interesting items being displaced forward in recall was not borne out in his first-recall protocols. For example, proposition 39 is perhaps the most unusually interesting proposition of the story. It is indeed well recalled, but it never occurs anywhere except in approximately its correct location. Most of the displacements that did occur were displacements of earlier material to later parts of the story.

To a large extent, Bartlett had to rely on the general meaning of terms such as "outstanding detail" or "sympathetic weather." His interpretation of the poor recall of proposition 2 was in terms of "a class of features which are very effective in setting up a sort of vague atmosphere of attitude, but do not provide outstanding detail, as a rule" (p. 80). A more general and predictive statement would be that setting propositions specifying locale, time, etc., are optional and will generally be poorly recalled. An interesting sideline to this argument is that when Paul (1959) changed the story to include mention of ghosts in proposition 2, and thus introduced a suggestion of major characters, recall of this proposition increased considerably.

Paul's study is relevant in another respect. He attempted to "fix up" the story and make it more coherent; in doing so, he added causal relations or explanations for most of the violations listed in Fig. 5 and omitted parts of sequences which we found arbitrary. The better structured version produced better recall.

Bartlett's analyses were directed more toward individual differences than to commonalities in recall. This emphasis may be what led him to conclude that analysis of omissions and transpositions would be a "fruitlessly long and weary task." With a grammar in hand, such analyses are much more likely to be fruitful, although possibly remaining long.

IV. A DEVELOPMENTAL STUDY OF STORY RECALL

An understanding of the structure of stories would be particularly useful to the developmental psychologist studying recall. Previous at-

tempts to specify the nature of differences in recall by children and adults have been hampered by the lack of analytic tools (e.g., Piaget, 1926). In particular we have had no way to assess whether children are as responsive to the organization of prose as adults and whether they use the same encoding and retrieval processes. It is possible that the differences in recall are purely quantitative due to lesser processing capacity, but it would be informative to determine if there are qualitative differences as well (Paris, 1975).

The classic work in the area of children's recall of stories is that of Piaget (1926) who was able to make a number of rather general statements about the recall of children from the ages of 6 to 8 years. Especially for the younger children in this age range, he reported that recall fails to respect temporal order, confuses cause and effect relations, is less complete than adult recall, and suffers from the egocentric use of pronouns (i.e., it is unclear in the recall protocols who is doing what to whom). By and large, this conception of children's recall has gone unchallenged. Fraisse (1963) reported that young children jumble the correct sequence of events when retelling stories. Korman (cited in Yendovitskaya, 1971) found that children frequently departed from the original sequence of events, although such departures were "accompanied by logically explainable 'jumps.' " It should be noted that Piaget found better temporal order in children's recall of stories than in their recall of other types of material, such as instructions on the use of a mechanical device. A major thesis of the present research is that correct temporal ordering is dependent on the degree of structure present in prose and that stories have a higher degree of structure than many other types of prose passages (cf. Thorndyke, 1975). In assessing children's ability to recall a story in correct temporal order, therefore, it becomes important to examine the structure of the stories being used.

Both Piaget and Fraisse assumed that the temporal inversions found in young children's recall were due to a failure to comprehend chronological, causal, and deductive relations. Brown (1975b) points out, however, that failure to recall a story in correct temporal order could be due to lack of expository skills rather than a true failure to comprehend order. She tested recognition, reconstruction, and recall of simple narrative sequences by kindergarten and second-grade children. For all children, logical sequences were retained better than arbitrary sequences, and for second-grade children the method of testing did not matter. Kindergarten children could recognize and reconstruct the correct sequences but had difficulty in maintaining the correct order during recall.

There seems to be general agreement, then, that the recall task poses unusual difficulties for young children. At the same time, there is considerable anecdotal evidence that young children often adequately

retell stories and plots of television cartoons (Brown, 1975a). The uncertain evidence in this area of study suggests again that the structure of the materials being used must be carefully examined before we can reach a sound conclusion about children's reproduction of temporal and causal sequences.

When we first began looking for stories to use in this experiment, we were struck by the great variation in degree of structure present in previously used materials. One of the three stories Piaget studied (the Swan story) has many of the characteristics of "The War of the Ghosts"; the last third of the story consists of unconnected events with little or no causal or temporal structure. The other two stories had clearer structure but tended to stress temporal connections between propositions in the surface structure, whereas causal connections are implied. Such obscuring of the relations among propositions should make recall more difficult. It may also be the case that poorly structured material affects children's encoding more than adults'. To the extent that young children have less processing capacity, presenting them with a poorly structured story may draw proportionately more of their processing resources away from succeeding propositions as they try to account for violations or lack of structure.

We were also struck by the lack of structure in many of the simple stories used in school systems to assess comprehension. Stein and Glenn (Note 4) used some of these "school" stories to assess comprehension and recall in the elementary grades and found many more temporal inversions than we did in the present experiment.[9]

We eventually selected the Dog, King, and Boy stories discussed in Section I. The Boy story was a structurally clearer and more complete version of the Epaminondas story used by Piaget (1926). We also included Piaget's Niobe story, leaving out the unusual name and changing the many "then" connectives to causal ones more appropriate to the particular nodes being joined.

Method

Subjects. Twenty-one subjects from each of the first and fourth grades and from the university were used in the final analyses. Eight first-graders and four fourth-graders were unable to recall one or two stories and were replaced. The elementary school children were from a public school in a middle-class district. University students participated for credit in an introductory psychology class. Because of University of California admission requirements, the adult sample's scores may overestimate recall compared to the general adult population. There were approximately equal numbers of males and females in the three groups.

Stimulus materials. The four stories were tape-recorded to eliminate variations in

[9] Some comprehension tests ask questions about a story which seem to direct attention away from important structural characteristics to trivial details. Presumably children's further reading of stories will be adversely affected by such testing.

inflection in presentation across subjects. Care was taken to give approximately equal emphasis to each proposition.

Design. Each subject recalled two stories. First one story was told and recall was tested after a 10-min unrelated visual recognition task. Then the other story was told and recall was tested 24 h later. Stories were counterbalanced across presentation order and each story was paired with each other story approximately equally often.

Procedure. Subjects were tested individually. They were told that the experimenter was interested in how people remember stories, that they would hear two stories and later be asked to tell them again as exactly as they could. Then the first story was played. Following a 10-min interpolated visual recognition task, subjects were asked to recall the first story. For the first- and fourth-grade subjects, the experimenter asked them to tell the story to another adult (with whom they were familiar) who was not present during the original telling. It was hoped that this procedure would reduce any tendency to summarize rather than recall. Instructions to all groups emphasized that verbatim recall was requested. Following the first recall, a few minutes were spent collecting age and other pertinent information about the subjects. Then the second story was played. The experimenter (or other adult) returned 24 h later to collect the second recall data. Both recalls were recorded and later transcribed.

Scoring procedures. The transcribed protocols were scored for presence or absence of each proposition. Four scorers were used. Rather than using a mutual training procedure designed to produce high interrater reliability, it was decided to use a double-criterion method. A strict criterion was used in which there was consensus that the recalled proposition expressed the meaning of the relevant proposition in the story. A loose criterion was used to include propositions about which there was disagreement among scorers.

Since we were interested in the structural characteristics of recall rather than the egocentric use of pronouns, we did not score a proposition as missing if it included the wrong pronoun. Misuse of pronouns was frequent in the first-grade protocols, in agreement with Piaget's findings. Egocentric references were rare in fourth-grade and adult protocols.

The analyses included only those subjects who recalled at least one proposition from the story. In attempting to elicit recall, the experimenter referred only to "the story you just heard a few minutes ago" or "the last story you heard before I left yesterday." This procedure was used because identifying stories by title or mention of the main character would have inflated recall of settings. If a child did not respond, probe questions were asked. These usually elicited partial recall of the story, but it seemed preferable not to include these data. Therefore, subjects were replaced if they did not spontaneously recall something from both stories. If the first-graders who did not recall anything were included and given scores of zero, the overall first-grade scores would, of course, be lower.

In addition to scoring presence or absence of the specified propositions, inversions of sequence of propositions within and between basic nodes and inversions of clauses within propositions were scored. Importations of new material (additions) were scored, and two kinds of elaborative clauses were scored for presence or absence: "temporal bridges" (e.g., when he got home) and "why clauses" (e.g., so it would not break into crumbs).

Results

The recall protocols from the immediate and delayed recall conditions were highly similar for all three groups. Mean proportion of propositions recalled for the immediate condition was .56, and for the delay con-
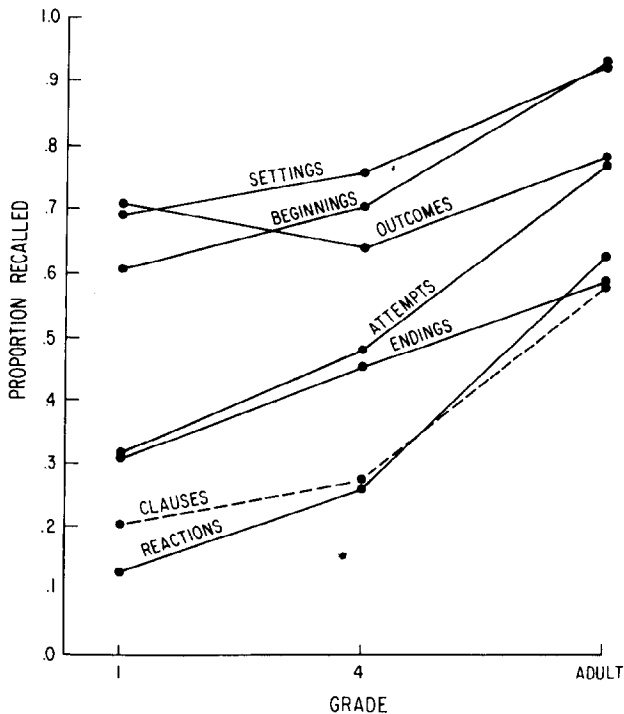
Fig. 6. Mean proportion of clauses and propositions in basic nodes recalled by first- and fourth-graders and adults.

dition, .61. Therefore, the data were collapsed across delay conditions. There were no sex differences in recall (male, .59; female, .58).

Every story had one or more propositions representing the six major nodes in the grammar: settings, beginnings, reactions, attempts (including actions), outcomes, and endings. Attempts and actions were combined since there was not enough of each kind per story to assess them separately. Similarly, reactions included both simple and complex reactions. The number of propositions recalled from each of these six types of node was calculated for each subject across the two stories that subject heard. This score was then expressed as a proportion of the total number of such propositions that were present in the two stories combined. These data were analyzed by two mixed-design analyses of variance, one using the strict criterion and one the loose criterion. The results for the two analyses were highly similar, the only difference being that the scores using the loose criterion were slightly higher. The results using the strict criterion will be reported here. The mean proportion of propositions recalled for each type of node is shown in Fig. 6.

In general, the adults recalled more than the fourth-graders, who in turn recalled more than the first-graders, $F(2,60) = 21.01$, $p < .001$.

Recall of the six kinds of node also differed markedly, $F(5,300) = 37.58$, $p < .001$, and adults and children recalled the various nodes differentially. A Bonferroni t test breakdown of the age by node interaction, $F(10,300) = 2.43$, $p < .01$, showed that the recall of first-graders formed two clusters: settings, beginnings, and outcomes were well recalled, and attempts, endings, and reactions were poorly recalled. The most general description of the first-graders' protocols is that they mentioned one or more of the main characters, the event that got the story going, and the outcome that resulted, omitting the internal reactions of the characters or what they did, as well as the final ending of the story.

The fourth-graders showed a similar pattern of recall, although there was no longer a significant differentiation between recall of attempts and outcomes. The adults recalled attempts almost as well as settings, beginnings, and outcomes. Recall of endings and reactions still lagged significantly behind.

These findings, illustrated in Fig. 6, indicate similarities as well as differences in the kinds of retrieval activity engaged in by children and adults. In general, adults recall more; the only node which did not show a significant age trend was outcomes. However, the similar ordering among nodes in the three age groups suggests that even the younger subjects are sensitive to the structure of stories and have schemata which organize retrieval in a fashion similar to adults. These data are consistent with those studies of recall of word lists which demonstrate that young children are capable of organized retrieval when the list structure has been made clear (e.g., Worden, 1974).

The main differences in the story schemata of the younger children seem to be the greater weight placed on outcomes than on attempts and in the almost complete loss of reactions. Although we did not use probe questions in this study, other data indicate that children could have answered questions about the reactions and attempts (Berndt & Berndt, 1975; Stein & Glenn, Note 4). That is, we believe the lack of recall does not primarily reflect a lack of comprehension. Rather the schemata which young children use to organize their recall emphasize the outcomes of action sequences rather than the actions themselves or the internal events motivating them. If they recall anything beyond the setting, it is most likely to be the outcome of an episode.

Figure 6 also shows recall of elaborative clauses. It had been predicted that these clauses would be less well recalled than the basic nodes, and an analysis of variance confirmed this prediction with one exception. Reactions, which on the basis of their optional deletion were also predicted to be poorly recalled, did not differ significantly from clauses. Descriptive adjectives and adverbs were also poorly recalled but were not directly compared to clauses and basic nodes because of their lack of comparability in length of expression.

The number of basic nodes, propositions, and words in each story is

TABLE 7

MEAN NUMBER OF BASIC NODES, PROPOSITIONS, AND WORDS IN EACH STORY
AND PROPORTION OF NODES RECALLED BY EACH GRADE

	Story			
	Niobe	Dog	Boy	King
Number of basic nodes	6	6	11	13
Number of propositions	10	11	18	18
Number of words	70	98	186	102
Proportion recalled				
First	.50	.71	.62	.30
Fourth	.61	.80	.69	.49
Adult	.88	.88	.88	.66
Mean recall	.66	.80	.73	.48

shown in Table 7, along with the mean proportion of basic nodes from which at least one proposition was recalled. Inspection of this table shows that length of story, as defined by any measure, was not a major determiner of amount of recall. The only story with substantially poorer recall than the others was the King story. This story was less well structured. It contained two incomplete episodes, and in both of these episodes the actions were poorly recalled. The two apprisals (the heroes hearing the cries and the king hearing of the rescue) were also rarely recalled.

Three kinds of sequence inversions in recall were scored. An inversion could occur between two basic nodes; that is, a proposition from a later node in the story could precede a proposition from an earlier node. Inversions could also occur between terminal nodes within a given node, and in propositions which contained more than one clause, within the proposition itself. Probability of occurrence of inversions depends, of course, on completeness of recall; two nodes or clauses can be inverted only if both occur in recall; therefore, inversions were scored as percentages of opportunity for occurrence.

Sequence inversions *between* basic nodes were very rare. Only 2% of the more than 800 nodes recalled across subjects and stories were out of order. This finding supports the hypothesis that well-structured stories produce well-ordered recall. The data do not support Piaget's contention that young children jumble the order of a story. Not only were there no differences in this regard between children and adults, but absolute level of sequential ordering was extremely high for all groups.

Most of the few inversions which did occur were found in the Boy story at the THEN connection between the two episodes. It had been predicted that this type of connection would result in looser structure

TABLE 8

PROPORTION OF SUBJECTS PRODUCING ADDITIONS DURING RECALL, TOTAL NUMBER
OF ADDITIONS, AND PROPORTION OCCURRING IN EACH CLASSIFICATION

	Proportion of subjects	Total	Emphatic or redundant	Reasonable elaboration	Irrelevant or structural fillers
First	.50	33	.15	.36	.48
Fourth	.69	49	.41	.31	.29
Adult	.64	51	.49	.35	.16

than causally connected episodes. One child reversed the order of the two episodes, but the more typical distortion in recall was to omit the last proposition of episode one (proposition 10), begin the second episode, and then backtrack to pick up the proposition later. This unusual sequence of recall provides an interesting illustration of the use of a schema as a retrieval device. Episode one is structurally complete with proposition 9. During retrieval, the episode appears to be satisfactorily completed without proposition 10; only when its content becomes relevant during the course of the next episode does this proposition appear, out of order, in recall.

More sequence inversions occurred between propositions within basic nodes (6.3%) and between phrases within propositions (14.7%) than between basic nodes. There were fewer sequence inversions within basic nodes than had been expected, in part because typically only one proposition from a node was recalled. Of the inversions that did occur, 88% were between AND and THEN connected propositions.

Additions or importations of new material during recall were classified into three types. The first class consisted of emphatic additions (e.g., "ferocious" dragon) or of repetition of a proposition expressed in a slightly different way. The latter frequently appeared to be an attempt on the part of the subject to ensure that the experimenter knew what character or action was being referred to. The second class consisted of a reasonable elaboration of a proposition, such as adding a presupposition, or explaining in more detail how or why something happened in the story. This class also included the addition of a reasonable new node; most frequently, such additions consisted of adding a reaction missing from the surface structure. The third class included irrelevant elaborations and propositions which filled the structural requirement of a node but with wrong material.

Table 8 summarizes additions in terms of the proportion of subjects who produced them and the proportion of additions of each type. The majority of subjects produced some additions, although these were frequently minor, as in the emphatic additions of adjectives. First-

graders produced fewer additions than the fourth-graders and adults, but the additions they did make were often irrelevant, even fanciful. Such additions typically appeared when the child got lost early in recall. The protocols suggest a knowledge that there was more to the story and a need to fill the empty nodes, but no ability to retrieve anything relevant.

It was predicted that additions would serve to fill missing nodes. The stories in this experiment were too structurally complete to allow a good assessment of this prediction. Twenty-three of the additions consisted of missing reactions and structurally appropriate substitutes for misrecalled nodes. If one discounts the minor emphatic and redundant additions, 28% of the remaining additions were of the structural type. Thus, a substantial proportion of additions filled missing nodes or supplied the structural requirements of nodes whose correct content was not retrieved, but other kinds occurred as well.

V. DISCUSSION

Our long-range goal is to be able to predict precisely what people will and will not remember from connected discourse. We have limited the domain of study to simple stories because they have more transparent structure than many other types of prose. Folktales and other simple stories are based on a relatively small number of formats, consisting of a delimited set of event sequences connected in common ways. People assimilate these sequences to form story schemata that guide comprehension and control retrieval from memory.

Our method of attack on a theory of story schemata has been to develop a grammar which will relate the surface structure of stories to the underlying structures on which schemata are based. To date, we have stressed the "syntactic" aspects of stories, ignoring detailed specification of the semantic content that should appear in a given node. Eventually, rules must be formulated which describe why one particular kind of reaction, for example, is an acceptable response to a beginning event and another is not. In addition to rules for allowable content (which may result in a kind of whole-earth catalog), ritualized sequences in stories, such as Colby (1973) and Propp (1968) have detailed, must be considered as well as questions of symmetry and redundancy, all of which undoubtedly affect recall.

Before the grammar can make even modest claims to adequacy, it must be expanded to include more precise transformational rules governing the relationships between the surface and underlying structures. Because the overriding consideration at the beginning of our grammatical enterprise was to define the overall characterization of underlying structure, we have emphasized the basic units and their connections. Investigation of transformational rules and their formalization is probably

the most urgent requirement before the relationship between what people hear and what they remember is understood. In the simplest stories the parsing of the surface into its underlying representation is straightforward; all nodes are represented in the surface and occur in canonical order. Clearly, stories vary in the degree to which they follow an ideal format, and many of the ways in which units are rearranged or deleted have yet to be explored.

Judgments of what makes a well-formed story are largely intuitive. With a set of grammatical rules in hand, we will define a well-formed story as one which follows the assigned rules. The justification of the grammar will then rest not upon intuitive judgments of "grammaticality," nor even on ease of comprehension but on how well the stories it defines as well-formed are remembered.

One of the reasons for resting the grammar on this base is that many effects of the schemata we are seeking to characterize can more readily be seen in the operation of memory processes. For example, some of the transformations we have discussed do not appear to affect comprehension as much as recall. There are more options during encoding; people can follow and make sense of many kinds of twists and turns in incoming material. Even highly irregular sequences which do not match any familiar schema can be temporarily maintained. Memory is less rich and flexible. Not only does memory simplify, but material presented in an unusual sequence will gradually conform to a more logical structure than the one constructed during input. If the structure imposed at input was a new one, it is apt to be unstable, and if the material can be retrieved at a later time, more familiar schemata will be used. An example of an unstable organization being replaced by a more familiar schema has been shown by Mandler and Parker (1976) for pictures of complex scenes.

Some of the most dramatic examples of a change in schema from encoding to retrieval are those of Piaget and Inhelder (1973). A child encoding a row of seriated sticks does so on the basis of his or her current concept of seriation and makes a reconstruction appropriate to the level of comprehension operative at the time of input. When asked to reproduce the sticks some months later, the child uses the concept of seriation as a retrieval cue, but the concept has changed. Thus, what is reproduced the second time may bear little resemblance to the original reconstruction.

These considerations indicate that memory is less strictly determined by processes occurring at the time of encoding than is suggested by some current conceptions of memory (e.g., Craik & Tulving, 1975). In many cases the schemata used to encode a story will be adequate to effect accurate recall. However, a noncanonical story may be mapped onto a reasonable schema during encoding, and perhaps tagged at places of

deviation, yet will settle down into a more canonical form. It is that idealized form of a story which we have attempted to capture.

Our data comparing recall by children and adults suggest that story schemata differ somewhat at various points in development and that consequently there are qualitative differences in recall. At the same time, we can say why our data disagree with those of Piaget (1926). Since we can point to differences in the structure of various stories, we can predict more accurately which stories will result in correct temporal ordering in recall and which will not. These are some of the advantages one should demand from a structural analysis; it should give us more insights into the nature and remembrance of things parsed.

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