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ABSTRACT

It is proposed in this report that theories about reading processes and about the structure of what is read can be readily formulated in schema theory terms. Previous work on the structure of texts is first reviewed and problems with earlier formalisms and scoring methods are discussed. Analyses are then presented of the structure of three types of texts--short stories, instructions, and explanations--and three experiments are described in which differences in readers' recall of the different text types were assessed. In experiment one, 22 college students read and summarized six texts of different types and later recalled three of them; in experiments two and three, students heard tape-recorded texts, one at a time, performed a brief interfering task after each text, and then recalled the text. Results of the experiments, which are reported and discussed, revealed that stories were the easiest, and definitions the most difficult, to recall and understand, and that recalls of definitions showed significantly more reordering than did recalls of instructions, which, in turn, had more reordering than did the recalls of stories. Forty-one illustrative figures and eight tables of results are included. (GW)

DEPARTMENT OF PSYCHOLOGY

UNIVERSITY OF SOUTHERN CALIFORNIA

Technical Report No. 85

SUMMARIES AND RECALLS FOR THREE TYPES OF TEXTS

May 1978

Lynn Gordon, Allen Munro, Joseph W. Rigney and Kathy A. Lutz

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A theoretical orientation for the study of different types of texts is presented. Schema theory is proposed as a useful meta-theory within which to develop specific theories about reading. Both theories about the processes of reading and theories about the structure of what is read can be readily formulated in schema theory terms. It is proposed that readers make judgments about the types of texts that they read and that these judgments bring about the activation of,

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) expectations with respect to the structure and meaning of these texts.

Previous work on the structure of texts, primarily for simple narratives, is reviewed. Problems with earlier formalisms and scoring methods are discussed, and heuristics for avoiding these problems are presented.

Three types of texts were selected for study. One type was the simple short story, a type closely related to (and, in some cases, identical with) the kinds of texts studied by other researchers. The second type studied were instructions. The third type was definitional explanations, a type well characterized by popular science articles. Detailed analyses of the text structures and text semantics for eight texts (three stories, two instructions, and three definitions) are presented. Texts of the different types differ from each other in consistent ways on two dimensions. First, the text structures of definitions tend to be organized horizontally rather than vertically, as are the text structures of stories and instructions. Second, the semantic representations of stories are composed of specific concepts, in schema theory terms, while the semantic representations of instructions and definitions consist primarily of generic concepts. On the basis of these differences among the texts, we predicted that stories would be better remembered than instructions, which would, in turn, be better remembered than definitions. Three experiments were conducted to test this hypothesis.

In experiment 1, subjects read and summarized six texts and later recalled three of these texts. Analysis of the summary data indicates that texts of different types are summarized to about the same extent. The recall data, however, suggests that text type may determine the amout recalled. Analysis of the recall data showed that, although stories were remembered best (as had been predicted), the propositional content of definitions was remembered better than that of instructions. It was hypothesized that rereading and summarizing may have had a differentially facilitative effect for later recall, benefiting the recall of definitions more than instructions.

In order to test this hypothesis, experiments 2 and 3 were performed. Subjects heard tape recorded texts (in experiment 2 the same set of texts used in experiment 1; in experiment 3 a somewhat different set), and, after performing a brief interfering task, recalled each text after hearing it. They were therefore not able to reprocess texts as they had been able to in experiment 1. In general, the results of these experiments confirmed our predictions: stories were recalled better than instructions, which, in turn, were recalled better than definitions. Subjects' recalls in these experiments were also scored for the amount of <u>reordering</u> of the textual material. This analysis showed a very powerful effect due to text type. Recalls of definitions showed significantly more reordering than did recalls of instructions, which, in turn, had more reordering than did the recalls of stories. These results are also in accord with our theory

(continued on following page)

that stories have more hierarchical, differentiated text structures than do instructions or definitions, and that definitions have less hierarchical structures than do instructions.

Subjects in these two experiments were also requested to cluster the texts in natural groups according to their types, as they perceived them. Their groupings were remarkably consistent with our own classifications.

The research presented demonstrates the need for a more thorough investigation both of the nature of people's expectations for differences in different types of text, and of the effects of such expectations on understanding and memory. Further research is also needed to explore the hypothesis that texts of different types may benefit differentially from the application of particular learning strategies, such as rereading and summarizing.

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SUMMARY

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I. INTRODUCTION

A small number of psychological researchers have recently begun to study the nature of people's knowledge about text structure and to investigate how such knowledge may guide their understanding of texts during reading. Rumelhart (1975) presented a "schema" for stories. In his theory, stories have both a grammar, which contrains the way in which constituents (in particular, the major meaning-bearing components) of a story may be ordered, and a semantics, which contrains the meaning relationships that can hold among the constituents of the story. Rumelhart also presented a set of rules for producing summaries. These rules were to produce all the acceptable summaries of a story when given as input the semantic structure of the story. Thorndyke (1977) proposed a grammar for the structure of stories. The structures produced by such a grammar for particular stories were used to interpret phenomena associated with the recalls and summaries of those stories. Mandler & Johnson (1977) also present a structural analysis of texts that includes semantic aspects. They introduce the concept of transformations in textual structure. In addition, they use their structures for stories to analyze the recalls of both children and adults in a developmental study.

This work and other related studies (Graesser, in press; Kintsch, 1975; Kozminsky, 1977; McKoon, 1977; Meyer, 1977) have opened a new field of cognitive and reading research. Using new analytic techniques borrowed in large measure from linguistics, these researchers studied the effects of supra-sentential relations on the understanding, recall, and summarization of texts. In the process of attempting to adopt the theoretical formalisms of Mandler & Johnson, Rumelhart, and Thorndyke, we found certain inconsistencies in the treatments proposed by the different researchers. Although each of these researchers has written as though the work of the others could be taken as at least partial confirmation of his or her work, there are some difficulties in comparing their published results. These difficulties are due in part to the use of the same or similar formalisms to convey different functions and in part to occasional inconsistencies in a given researcher's use of a formal mechanism. Although different research groups have sometimes used the same texts, they have never analyzed these texts in the same way. These problems are discussed in detail in "Text Analysis Methods" below, and explicit conventions are proposed. These conventions should enable replication of our text analyses.

Previous work on the relationship between text structure and the understanding of and memory for texts has been devoted to studies of simple stories. There are many other types of texts as well. We set out to apply the techniques developed by Rumelhart, Mandler & Johnson, and Thorndyke to text types other than stories. Only by studying a variety of types of texts can one come to know what aspects of text processing are universal and which are governed by the reader's knowledge of the type of text being processed. In our view, there are a very large number of possible text types, at least from the viewpoint of the sophisticated reader. In our experimental work reported below, three different types of texts were studied. These were <u>stories</u>, texts of the same type as those studied by Rumelhart (1975, in press-a), Thorndyke (1977), and Mandler & Johnson (1977); <u>definitional explanations</u>

texts that introduce new technical concepts; and instructions, texts that give a prescription for achieving some goal. The text structures proposed for these types of text are presented below in the section "Text Types."

Theoretical Orientation

Our work is an extension of a broader model in which reading is viewed as a kind of externally guided thought (Rumelhart, in press-b; Rigney & Munro, 1977). According to this theory, many different conceptual entities, called schemata, are activated during reading. Some of these schemata are activated by the presence of particular letters in the text, others by particular words. Some schemata represent other familiar concepts, not expressible in a single word, that were evoked by the text. In addition, a schema may be activated that has the entire text in its scope. (See Munro & Rigney, 1977, for a discussion of the scope of schemata.) Such a text-schema includes the reader's knowledge about what kind of structure the text will have.

Figure 1 sketches the text-understanding process. Reading the text results in the activation of a number of old schemata. These include pre-existing representations for words in the text, for some supra-lexical concepts conveyed by particular combinations of words, and for the text type. Some of these pre-existing schemata are sufficiently activated that they bring about the creation of new schemata to represent the meaning of the text as the reader understands it. These new schemata constitute a record in long term memory of the reader's understanding of the text.

Figure 2 sketches our view of what happens when a reader is later asked to recall a text that was previously read. The recall cues given in the instructions activate some of the schemata that were created in the course of the text understanding process. These schemata activate more of

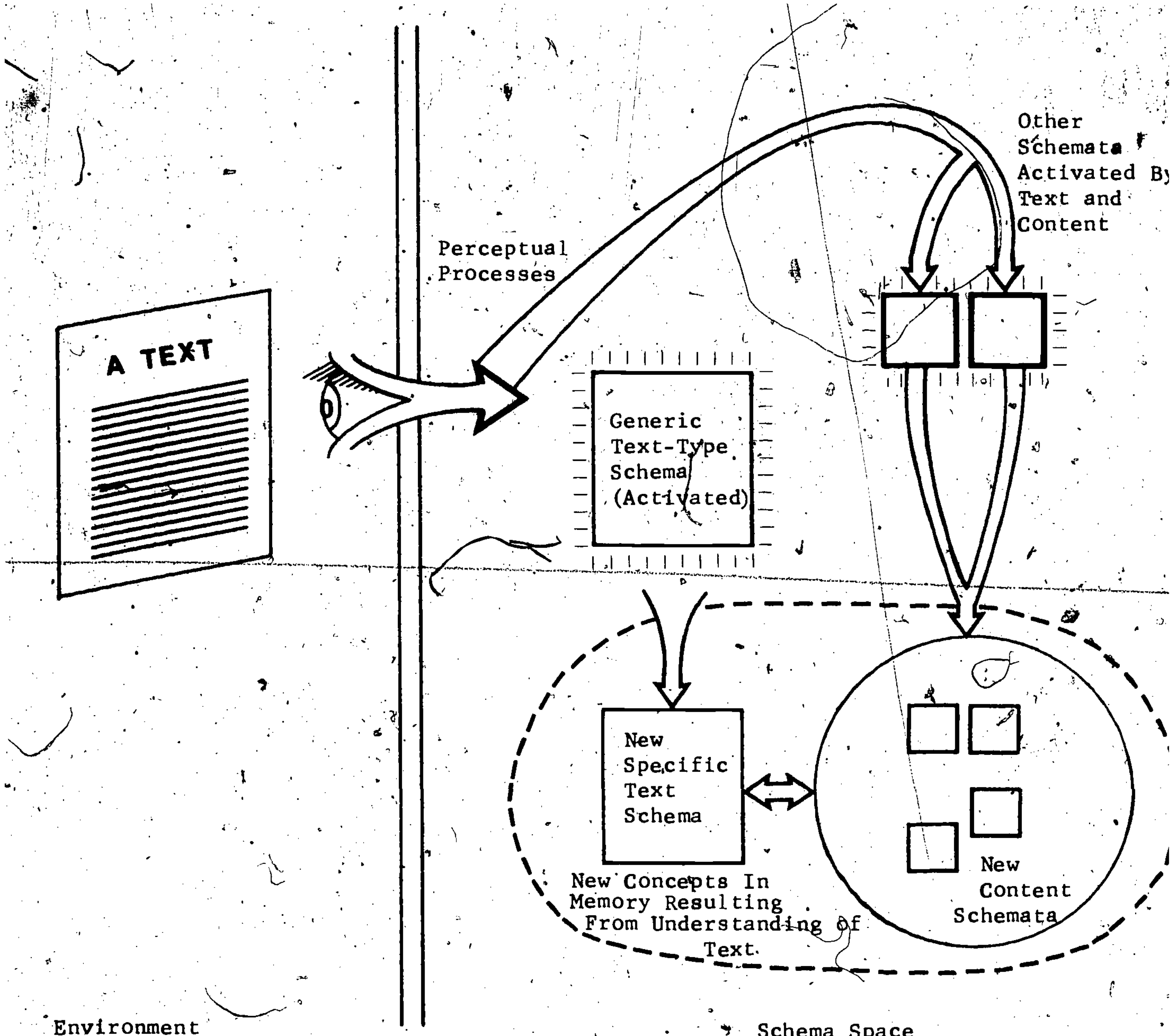


Figure 1

Text Understanding

Schemata Encircled By "Balloons" Are Newly Created As A Result Of The Text Understanding Process.

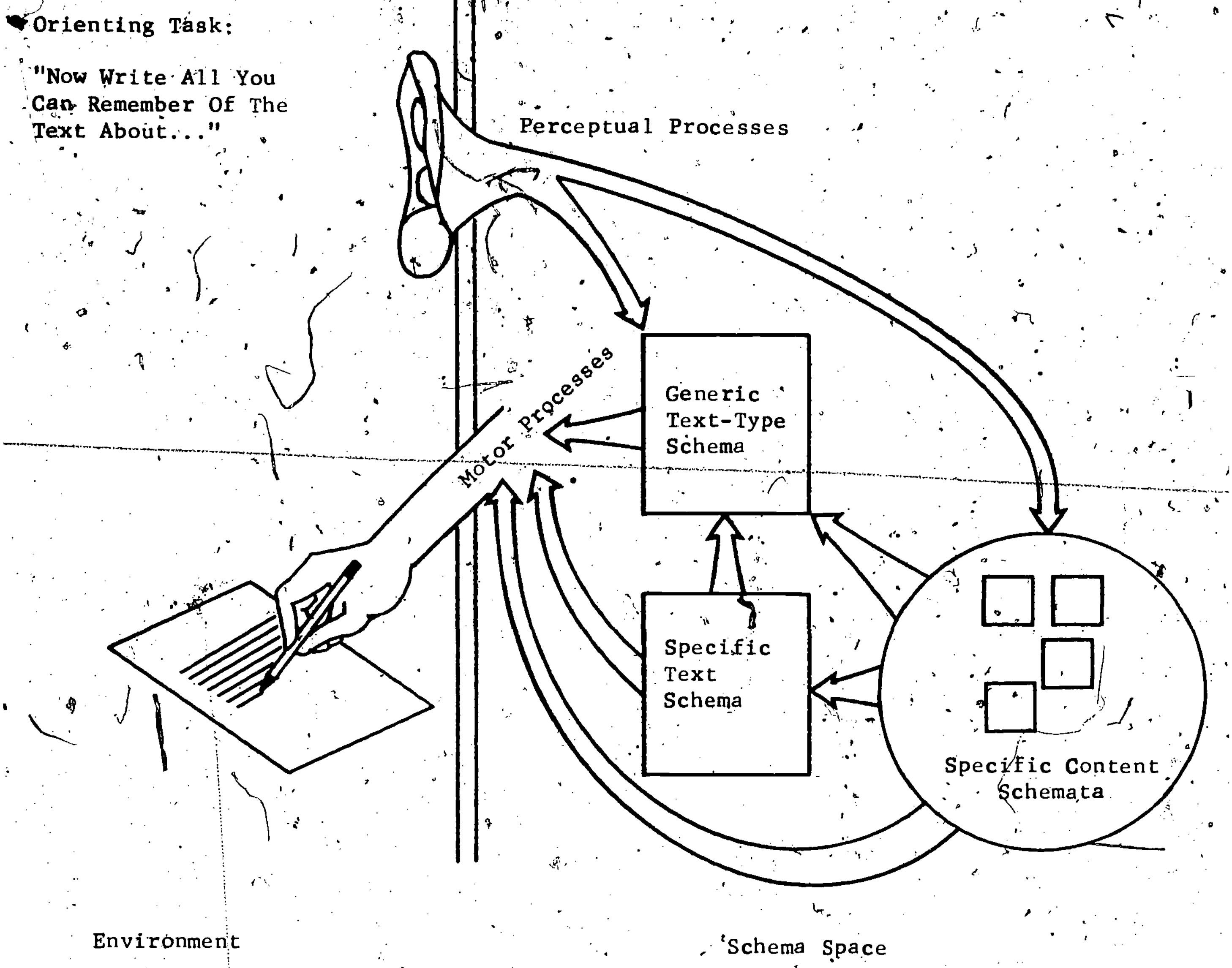


Figure 2

Text Recall

All Schemata Depicted Are Assumed To Have Existed Prior To The Presentation Of The Orienting Task; The Orienting Task Activates Them.

the records of the text, including the specific text schema for that text. All these activated schemata then "cooperate" with the generic schema for the text type of which the particular text was perceived to be a member; motor processes are activated and a recalled text is generated.

There are, we believe, a variety of text-type schemata--essentially one for each major type of text that a reader knows about. When a reader reads a story, his or her Story Schema is likely to be activated. When a text gives instructions on how to accomplish something, readers should experience an activation of their instructions schema. And when a text is written to explain or define some new technical concept, a reader who is familiar with that type of text will have an activated Definitional-Explanation Schema.

A given text-schema will contain a variety of information about the type of text it represents. It may contain information about the level of difficulty of vocabulary that can be expected in the text-type. It may specify types of stylistic devices that are likely to be used, or the level of (sentential) syntactic complexity that is typical of the text-type. The kind of information about texts that most concerns us here, however, is information about the expected structural characteristics of the text-type. There are two aspects to these structural characteristics, which we call text-structure and text-semantics.

A text-schema for a particular type of text will include information about the probable sequence of the major constitutents of a text of that type. This sequence is the text-structure of the type. Naturally, these sequence expectations are not simply lists of the most likely ordering of text components for the various text types. The expectations are more flexible; they include specifications for optional sequences and optionally recursive constitutents. One convenient way of describing such structural expectations is to make use of the formalism of phrase structure grammars. A phrase structure grammar is a set of rewrite rules which generate syntactic trees. Their use in this work and that of previous investigators is not meant as a psychological model of the production of texts. A rule such as:

PLOT ⟶ PURPOSE + ATTEMPT* + OUTCOME

does not mean that a story-writer proceeds to construct a plot by planning to have first a purpose, then some arbitrary number of attempts to accomplish that purpose, then an outcome. What it means is that the reader of a story expects the plot portion of that story to set up some purpose for the protagonist, which will then be followed by a number of attempts on the part of the protagonist and, finally, by some outcome. The sets of rewrite rules used in psychological theories of text structure are generative only in the technical sense. They are meant not as models of text production, but rather as models of part of the knowledge that contributes to the understanding of particular texts.

The second kind of information about the structural characteristics of a type of text embodied in a text-schemata is the text-semantics of the text-type. The text-semantics of a text-type specifies the expected meaning relationships that should hold among the major constituents of a text. Rumelhart (1975) presented one way of characterizing these relationships. In his theory, semantic interpretation rules operate on the structures produced by the grammar components. In effect, syntactic rewrite rules have associated semantic interpretation rules. If Rumelhart had proposed a grammar rule such as that given above, the associated semantic interpretation rules would look like this:

MOTIVATE (PURPOSE, ATTEMPTs)

THEN ($ATTEMPT_1$, $ATTEMPT_2$...)

CAUSE ($ATTEMPT_n$, OUTCOME)

However, this approach to text-semantics is not equally appropriate for all text types.

II. TEXT-TYPES

Rigney (1976) and Rigney & Munro (1977) presented a tentative typology for text-types. Four major types of texts were described: narratives, prescriptions, explanations, and representations. Narratives were characterized as featuring temporally-related episodes, protagonists, and plots. Narrative texts deal with concrete referents and have causal sequences. Prescriptions were described as rules for doing things, ranging in type from written rules-of-thumb to step-by-step instructions to legal statutes. Explanations were characterized as sequences of inter-related definitions and descriptions. Representations were introduced as the text-type that restates or takes the place of figural supplements to texts.

In our current view, this simple four-way typology for all texts may be an oversimplification. We believe that there is no magic number of text-types because perception of text-type membership may be an idiosyncratic function.

The significance of a text-type, in our theory, is that people have a schema for texts of that type. That is, they expect that a given text will have certain structural characteristics--both in terms of the sequence of its major constituents (the text structure) and in terms of the meaning relationships that hold among these constituents (the text semantics). Once a reader recognizes that the given text is an example of a certain type of text, then the reader will classify the text in terms of that text-type. Yet, other readers might say that this particular text was an instance of some other text-type that the first reader does not know about. If, for example, a young child had read and heard only two types of texts, say stories and instructions, then, upon encountering the first example of an explanation, the child would be likely to classify it as an instance of one of two text-types that it did not know about. Of course, this would result in many comprehension difficulties for the child, since the sequence of constituents in the text would not match very well with whatever text-schema was activated.

There are probably a large number of different text-schemata, and different people possess different ones of them. A psychology scholar, for example, is likely to have a special schema for the structure of the psychological journal article. He or she may even have different schemata for the structure of articles in different psychological journals. Some people may possess different schema for the structure of stories in different types of comic books. Of course, this does not mean that there are not also some more general text-type schemata that reflect our knowledge about the similarity among some of the different types of texts. Thus, one person might experience an activation of both a Comic Book Schema and a Narrative Schema while reading a comic book, and a Narrative Schema while reading an Aesop's fable, both a Serious Novel Schema and a Narrative Schema while reading The Possessed, and so on. In some sense the Narrative Schema would be expected to make less explicit claims about the structure of the text being read than would any of the other three schemata just mentioned. It may be that some broad classification of texts--such as that into the classes of narratives, prescriptions, explanations, and representations--will prove a useful way of characterizing the most general knowledge that people have about possible types of texts. It is not our purpose here, however, to defend a particular classification of texts. Our goal is to see how people remember and summarize texts of several different types.

Three text-types were chosen for our studies: stories, instructions, and definitional explanations. These types are not as abstract as types like narrative, prescription, explanation, and representation. That is, fewer texts can be appropriately classified as stories than as narratives; fewer texts are instructions than are prescriptions; and fewer are definitional explanations than are explanations. Texts of each type were used in the experiments described below. The three stories used were "The Dog and Its Shadow" (see below) and "The Old Farmer and His Stubborn Donkey" and "Borrowing a Horse" (see texts A-1 and A-2 in Appendix). The two instructions used were "Redistributing the Filler in a Sleeping Bag" (see below) and "Making a Concrete Planter" (see text A-3 in Appendix.) The three definitional explanations used were "The Immune System (see below) and "Nematodes" and "Courtly Love (see texts A-4 and A-5 in Appendix.) In the sections following, detailed claims are made about the text structure and text semantics of these types of texts and about the particular examples of these text-types used.

Before presenting these detailed claims, an important difference between the semantics of stories and the semantics of the other types of texts should be pointed out. This difference has to do with the nature of the concepts that are stored as a result of reading the texts. When one reads a story, one understands that the new information conveyed by the story can be stored as new specific representations of old generic concepts. However, when one reads one of the other types of text, which we will lump together under the title "expository text," then one ordinarily cannot store the new information conveyed by the text as specific instances of old generic concepts. Very often, expository text is intended by the author to convey new generic information, rather than new specific information.

Let us briefly review the distinction between generic and specific concepts proposed in Munro & Rigney (1977) and Rumelhart & Ortony (in press). These are important constructs in schema theory, a procedural semantics model for cognitive processing. In schema theory, a generic concept is a cognitive entity in long term memory that stores information about types. These generic concepts or schemata are storage units that have the special property of also having procedural characteristics. When a schema is activated, as a result of sensory input or ongoing processing, then that schema can itself direct the flow of processing. Specific concepts have a different status in schema theory. They are stored information units that do not have this procedural aspect. When generic concepts are highly activated (when processing in context strongly "confirms" a schema), then the concept is instantiated. What this means is that a copy of the schema is created in long-term memory. The copy does not have all the attributes of the original schema. For one thing, the copy does not have the procedural character of the original schema. For another, the copy is not exact. A generic concept has many associated concepts that are only loosely specified; in effect, these are variables of the schema. The copy, on the other hand, has more strictly specified associated concepts or arguments; the copy of a schema has filled parameters. It is these copies of generic concepts that we refer to as specific concepts.

Stories, in general, are not expected to introduce new types. Rather, they present new specific instances of old types. One will sometimes encounter a new vocabulary item or a new concept in a story, but readers do not expect the introduction of such new generic concepts to be the author's primary purpose in writing the story. Expository text, on the other hand, seems to have the introduction of new generic concepts as its prototypical purpose. The text of the Immune System given below, for example does not presume that the reader is already well-acquainted with the concept of the immune system, and then proceed to teach the reader about some specific instances of the immune system. Rather, its purpose is to teach the reader what the immune system is. In effect, the author's intention is that the understanding of the text should result in the creation of a new schema--an Immune System Schema-- in the mind of the reader. Stories, on the other hand, are likely only to introduce new instances (or specific copies) of existing schemata.

Specific and generic concepts are given different kinds of semantic representations in schema-theory. Figure 3 represents the specific concepts embodied in the following story.

The Margie Story

> Margie was holding tightly to the string of her beautiful new balloon. Suddenly, a gust of wind caught it. The wind carried it into a tree. The balloon hit a branch and burst. Margie cried and cried.

The Margie Story is a very simple example of a narrative text. (It is not an example of a Story according to the definitions presented below, however.) Two types of records are differentiated in the representation

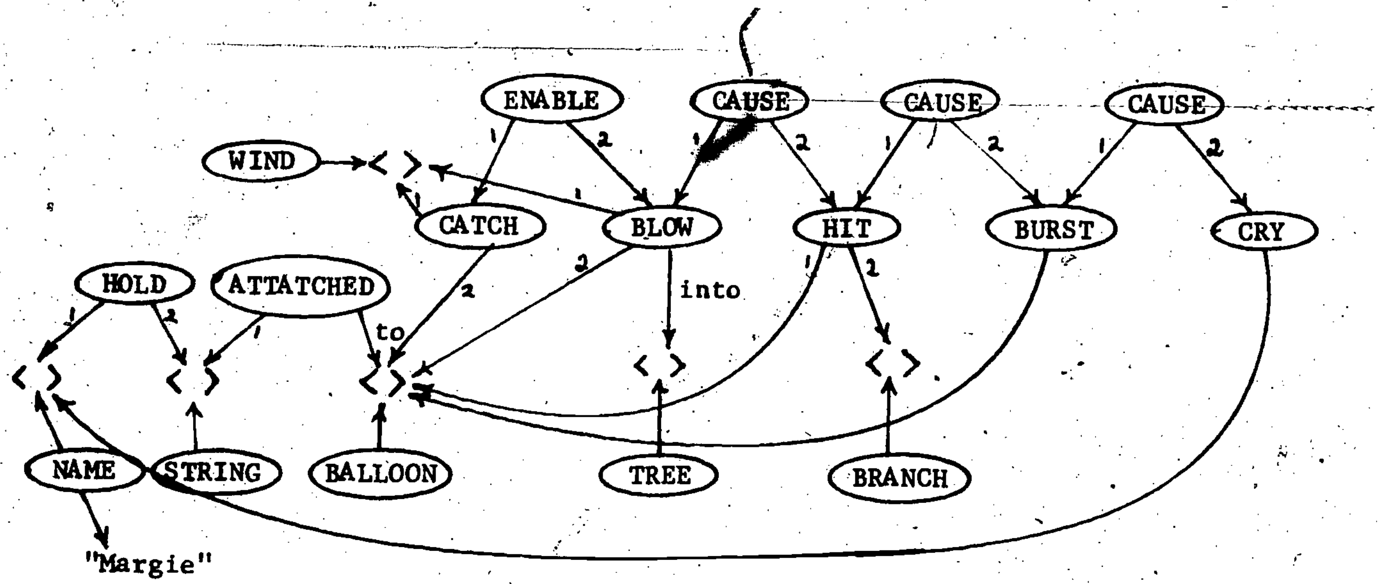


Figure 3. A semantic representation for "The Margie Story"

of this text shown in Figure 3. The pairs of angled brackets represent concepts of specific individuals. The ovals represent concepts of specific predications; these are specific copies or versions of the generic concepts whose names are used to label the ovals.

Consider now how generic concepts are represented in schema theory. The following very brief text could be classified as a definitional explanation in our partial typology of texts.

Gastric-Juice

> Gastric juice is the digestive fluid secreted by the glands in the mucous membrane of the stomach. It is a thin watery fluid having an acid reaction, and it contains several enzymes.

Figure 4 shows how generic concepts, such as those conveyed by this brief text are represented in schema theory. Figure 4 can be thought of as a computer program or procedure written in a kind of semantic operating language. It represents a simple schema for the concept of gastric-juice. Each line in the representation is a kind of subprocedure that names the other schemata that are called on by the Gastric-Juice Schema. These lines specify the scope relationships that hold among the schemata.

The differences in the nature of the representations depicted in Figures 3 and 4 is intended to reflect the functional differences between specific and generic concepts in schema theory. A representation like that in Figure 4 is meant to reflect the dynamic, procedural qualities of generic information. Specific information, such as that shown in Figure 3 has a more static quality. An activated generic representation can produce a specific representation, but the reverse is not ordinarily the case.

```
GASTRIC-JUICE (x)
        is when
DIGESTIVE-FLUID (x)
SECRETE (GLANDS (IN (GLANDS, MUCOUS-MEMBRANCES (OF (MUCOUS-MEMBRANCES, STOMACH))),x)
THIN-FLUID (x)
WATERY (x)
FLUID (x)
HAVE (x, ACID-REACTION)
CONTAIN (x, ENZYMES)
        end.
```

Figure 4. A Semantic Representation for "Gastric Juice."

III. TEXT ANALYSIS METHODS

Previous Models of Text Structure

Text analysis within the framework of schema theory has been focussed for the past few years on simple stories. Much work has been devoted to discovering an adequate representation of these stories and to testing experimentally the predictions based on these representations. These experiments have primarily consisted of asking subjects to summarize or recall some texts which the experimenter felt fell into the class of simple stories.

Each of the researchers who have attempted to analyze simple stories has presented a different set of rules. The rules (in Rumelhart, 1975, Thorndyke, 1977, and Mandler & Johnson, 1977) have been written as rewrite rules, a constituent on the left side of an arrow with its component constituents on the right. This formalism permits the concise expression of constituent relationships. The specific rule systems proposed differed both in what each rule contained and in what kinds of structures (syntactic and semantic) were supposed to be represented. Some differences are merely lexical--one researcher calls a constituent one thing while another calls it something else. For example, Rumelhart's episode seems to mean approximately the same thing as Mandler & Johnson's event structure. However, some differences are more significant: different constraints are put on different rule systems, different claims are made on behalf of these systems, and different levels of form and content are represented.

Out discussion will include criticisms that concern technical aspects of the use of rewrite rules. The technicality of these criticisms does not detract from their importance. Internal consistency is, of course, essential. In addition, it could clarify areas of agreement and disagreement if different researchers would use the same rewrite rule conventions. When we undertook the present research, we intended to apply the techniques used by earlier researchers (these techniques we initially perceived as essentially very similar to each other) to other types of text than simple stories. Only in the course of attempting to use these techniques in our own work did we discover that there were real differences in earlier treatments.

Where the generalization which a set of rules attempts to capture is incorrect, the supporting data must be re-examined. Where the generalization is correct, then the rules must be rewritten to reflect accurately the generalization. Internal consistency is the most important constraint on the use of these techniques and is no small achievement. Beyond these technical requirements lie greater theoretical and methodological issues. What is his system intended to represent? What are the advantages and disadvantages not of some particular rule, but of the entire rule system? What kinds of standards should rule systems attempt to meet? What kinds of claims or assumptions does any such system commit its proponents to? Finally, how can the analysis of particular texts be related to the rule system chosen?

The system Rumelhart (1975) proposed forms the basis of both the Thorndyke and Mandler & Johnson systems. This system consists of two parallel sets of rules: grammar rules which were to "generate the constituent structure of stories," and semantic interpretation rules which were to "determine the semantic representation of the story." The semantic interpretation rules specify the relationships between the components of the grammar rules, e.g.:

Rule 1 Story ⟶ Setting + Episode (A grammar rule)

Rule 1' ALLOW (Setting, Episode) (A semantic interpretation rule)

The examplars of a syntactic category are specified in terms of the nature of the acts which can fill the role of that component, what kind of agency instigates the act, the purpose of the act, etc. This detailed specification may result in more categories than are actually necessary. It does enable Rumelhart to represent more detailed kinds of semantic relationships than are probably needed to represent a story. The kind of detail as to what kind of causality exists between two components seems less a part of a story than a general knowledge of what kinds of relationships can hold between different kinds of entities in the world; see Fillenbaum (1978) and Munro (1978).

The Rumelhart grammar contains constituents which are apparently obligatory but which are rarely overt in actual stories. For example, he has the specific category, <u>internal response</u>, "The mental response of an animate being to an external event." In both the stories he analyzes in the paper, the content of that category must be filled in by inference from the overt reaction it 'motivates.' Thus, at no level in this grammar is there any distinction between what stories must contain and what is merely inferable from them. Moreover, there may be no principled way to decide whether these inferences are based on one's knowledge of the structure of stories or on one's knowledge of possible relationships between events or entities. The latter kind of knowledge should be distinguished from that based on the structure of stories, in which certain kinds of relationships are highly expectable.

Thorndyke (1977) presents a grammar "for simple, prototypical narrative structure...(this grammar is) similar to the one suggested by Rumelhart, having been simplified by the deletion of a few structural elements." Thorndyke does not specify exactly what structural elements he is referring to, nor even whether he is referring to conventions or formalisms or categories. He did reject Rumelhart's "|" which Rumelhart used to "separate mutually exclusive alternatives." Thorndyke appears to have replaced this with curly brackets, though he never makes explicit the use of this formalism. He also introduces the use of parentheses to indicate that some element is optional. (In Rumelhart's system, summary rules can accomplish the deletion of optional elements.) However, this "simplification" leaves Thorndyke with more rather than fewer formal devices. Thorndyke reduced the number of categories; in his system, everything finally rewrites to either state or event. Mandler & Johnson (1977) also employ this device, but its usefulness is not made clear in either report. In fact, this kind of economy of terminal symbols is very misleading. One of Thorndyke's rewrite rules (actually, it is his abbreviation for three rules) is the following:

$$10. \quad \left.\begin{array}{l}\text{CHARACTERS}\\ \text{LOCATION}\\ \text{TIME}\end{array}\right\} \longrightarrow \text{STATE}$$

This rule, interpreted literally, says that any STATE may fill the role of any of these three constituents (so long, we suppose, as the state appears at the appropriate sequential location in the structure of the story). This is plainly incorrect, since some STATE propositions are plainly only about location and cannot be interpreted as setting forth characters or time, no matter where the proposition appears.

Naturally, it is also true that some stative proposition can only be about characters or about time. Here is another example of this type of rule:

$$7.\quad \left.\begin{array}{l}\text{SUBGOAL}\\ \text{GOAL}\end{array}\right\} \longrightarrow \text{DESIRED STATE}$$

What is the point of having two structural elements that rewrite identically? If $x \rightarrow y$ and $z \rightarrow y$, why have both x and z? For that matter if x can only rewrite as one possible element, y, then why have both x and y? All that is gained is an extra layer of structure. If x and z are to represent different semantic content, representing the difference high up in the tree seems inappropriate. If x and y are claimed to be in some way structurally different such a rule might be maintained but Thorndyke suggests no such justification.

Another kind of formal infelicity can be found in Thorndyke's rule:

$$2.\quad \text{SETTING} \longrightarrow \text{CHARACTERS} + \text{LOCATION} + \text{TIME},$$

Where "+" "indicates the combination of elements in sequential order." Since there is an available device, ( ), for marking the optionality of some element, one can only assume that each of the elements in this rule is meant to be obligatory. However, in his representations of the individual stories used in his experiments this rule is not obeyed. For "Circle Island" the setting consists merely of a location; while for "The Old Farmer and His Stubborn Donkey" it consists only of characters. Thorndyke's applications of his grammar to particular texts fail to meet his own description of what a SETTING consists of.

It may be that Thorndyke wanted to represent the SETTING as consisting of any of these constituents or combinations of them. (This is a more reasonable analysis of the structure of settings.) Thorndyke's rule fails to capture this. Yet this analysis can be represented without introducing any new formalisms. A simple way to represent this situation is like this:

$$\text{SETTING} \rightarrow \text{BACKGROUND*}$$

$$\text{BACKGROUND} \rightarrow \begin{Bmatrix} \text{CHARACTERS} \\ \text{LOCATION} \\ \text{TIME} \end{Bmatrix}$$

These rules, while introducing a new element (and to that extent complicating the system), provide a more adequate representation. The CHARACTER, LOCATION, and TIME consitutents still form a larger constituent. Besides making any single constituent or combination of them available, it does not insist that any particular linear ordering is mandatory, which is well since there is no evidence that CHARACTERS must precede LOCATION and LOCATION must precede TIME.

Mandler & Johnson (1977) provide another "grammar of simple stories," different from the two previously discussed. They very explicitly state the nature of the narrative which they expect to represent, "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 in which a different character becomes the protagonist, but within a given episode only one protagonist is allowed."

Mandler & Johnson attempt to represent in their rewrite rules things which Rumelhart used both grammar and semantic interpretation rules for, e.g., within their rewrite rules they attempt to capture the semantic relationships that hold between consitutuents. Thus, the rules express both the constituents and the relationships that hold among them at the same level of analysis.

Mandler & Johnson constrained their grammar in such a way that terminal nodes or concatenations of terminal nodes do not appear at the same level as any more abstract node. They cannot have rewrite rules of the sort that would state:

DEVELOPMENT ⟶ SIMPLE-REACTION CAUSE EVENT

instead they must accomplish this using two rules:

DEVELOPMENT ⟶ SIMPLE-REACTION CAUSE ACTION

ACTION ⟶ EVENT

This kind of constraint makes for an uneconomical grammar. The problem grows out of Mandler & Johnson's requirement that every node must terminate in EVENT or STATE, which are uncharacterized. More specific relationships must therefore be expressed by more abstract nodes. This constraint causes the grammar to have at least three more rules than appear strictly necessary for purposes of merely representing the structure of the stories[1].

New and confusing notational conventions were adopted by Mandler & Johnson. The symbol * is widely used to denote that a category so marked may be optionally rewritten as any number of instances of the category, all concatenated. In the Mandler & Johnson work a new symbol, superscript n, is used to convey this function. The symbol * is then used to indicate that some terminal node is conjoined with other terminal nodes to a high level node, thus, EVENT* can contain STATEs. Confusion could have been avoided if the symbol * had not been given a new function. Instead, the convention in general use could have been maintained and

---

[1]The three rules are:

Action ⟶ Event
Goal ⟶ Internal State
Emphasis ⟶ State

33

some new convention should be introduced to represent the non-"basic" nature of the node represented by them as EVENT*. (Since the "basic node" is their own construct, its symbolic representation is entirely within their control.) In general, this system attempts to carry too much semantic information at the same level, obscuring structural generality.

Standards for Modeling Text Structure

The technical differences and inconsistencies in the use of symbols described above makes clear, we believe, the need for some set of guidelines for the construction of grammars of text structure. In the process of trying to understand the detailed implications of the formalizations used by earlier researchers and of constructing and revising our own text structures, a number of heuristics evolved. These fall into two classes: rules for using the rewrite formalisms and rules for actually choosing particular rules and the structures they could generate.

Rewrite-rule Rules. Rewrite rules are composed of the following elements:

Constituent names: These are arbitrary names of constituents in the text structure representations of particular texts.

⟶ : the rewrite arrow signifies that the element to the left of the arrow may be composed of (or realized as) the constituents to the right of the arrow. Only one constituent name may appear to the left of the arrow. Rewrite rules of the form A ⟶ B are not permitted. (That is, there must be either a concatenation of constituents or a choice of constituents (or both) to the right of the arrow. This prevents the generation of tree structures with long, thin, functionless branches.)

+ : This symbol indicates that the constituents whose symbols are to either side (A and B in the string "A + B") are contiguous, and that the constituent named on the left side of the + ordinarily will preceed the constituent named on the right side of the + in the text.

***** : When a constituent name is followed by *, the constituent can optionally be iterated at that point in the structure. A rule written A⟶B* is a shorthand form of the following rule:

$$A \longrightarrow \left\{ \begin{array}{l} B \\ B + B \\ . \\ . \\ . \\ B + B + \ldots + B \end{array} \right\}$$

( ) : Parentheses are used to enclose optional constituents. Thus, A ⟶ (B) + C means that element A may be realized by either constituent C alone or by B + C.

{ } : Curly brackets indicate that the elements enclosed are mutually exclusive alternatives, so a line $A \longrightarrow \left\{ \begin{array}{c} B \\ C+D \end{array} \right\}$ means that A ⟶ B <u>or</u> A ⟶ C + D. Constituents that appear only on the right side of the arrow in a set of rewrite rules are terminal nodes (they dominate only propositions, not other constituents). These constituents are defined for each text type as part of its rule system. Non-terminal elements are not defined; they consist of combinations of constituents.

Our aim in providing a syntax for each of the text-types we have studied is to characterize what is commonly present in these texts, i.e., to present the form into which the specific content of these texts is fitted. It is necessary to represent all the elements which must be present in some text to make it a realization of its category. What does a reader/ hearer expect to be present in a story?

A text structure should not attempt to represent all the possible inferences which the reader/hearer may make based on the text, nor should it aim at making every fine semantic distinction that might be made by someone armed with a finely-tuned logical system. Instead it should be designed to represent a broad range of relationships and content through a general outline of the pattern into which the content fits.

<u>Heuristics for Modeling Text Structures</u>. In writing rules we had several operating principles:

1. For the broad outline, we relied on our shared intuitions. Agreement with prior published analyses was taken as important support for such intuitions.

2. We assumed that the basic order of the constituents of a text-type was the order present in the texts where the texts were in agreement.

3. Where the texts disagreed, the difference was due to linguistic factors. The order in which the constituents where embodied in independent sentences was held to be basic. For example, in stories, the PURPOSE (MOTIVE) might be expressed in an independent sentence or in a subordinate purpose clause; in the first case (independent sentence), the PURPOSE would generally precede the first ACT of the ATTEMPT, while in the second case (subordinate purpose clause), the PURPOSE would generally follow the ACT (in keeping with the general tendency of subordinate purpose

clauses to follow the main clause in unmarked situations). We therefore, analyzed the structure of plots as having PURPOSEs preceding ATTEMPTs.

4. We limited constituents to those which are separable in form and present in the texts.

5. We limited new constituents to those which could not fit into categories already present in the analysis. We constructed new constituents only for those structures which could not be meaningfully represented in a level of structure or category already present in the syntax. A new structure was required to have some special function or dominance relation which has formal consequences.

6. Every semantic distinction does not necessarily entail a distinction in form. Only where a semantic distinction does result in a distinction in form is it of interest at this level of analysis. The content and its internal cooccurrence restrictions can be expressed elsewhere.

7. The rules should be as simple as they can be and yet produce all the possible structures of the appropriate text-type (every specification renders the analysis of a text-type less general).

8. The rules should be specific enough to represent one text-type uniquely.

9. The system should be consistent and avoid redundancy.

10. The rules should produce the proposed trees.

A representation system constructed according to these heuristics will be biased in favor of generality; any new layer of complexity must be justified. If such a system errs, it is in the direction of simplicity.

Some Problems with Previous Methods of Scoring Text Recalls and Text Summaries

Mandler & Johnson (1977) and Rumelhart (1975) score recalls for texts by splitting each text up into its component statements and then deciding which statements are reflected in a subject's recalls. Neither paper describes the process by which the texts were divided up into statements for scoring purposes. This has the unfortunate effect of implying that the process is intuitively obvious or well-known. That this implication is false can be deduced from the fact that in the two works just cited the same text is analyzed differently. In Rumelhart's treatment, for example, the story "The Dog and His Shadow" (see page 30) has 13 component statements, while in Mandler & Johnson's treatement the same text has 11 component statements.

Thorndyke (1977) made a real contribution by proposing an explicit system for dividing a text up into its component propositions. His system is apparently not the same as the unexplained systems used by Rumelhart and by Mandler & Johnson. Thorndyke analyzes "The Farmer and His Stubborn Donkey" (see text A-1 in Appendix) as having 35 propositions, while Rumelhart says it has 13 statements. Thordndyke's method centers on his definition of a propositon as "a clause or sentence containing an action or stative verb." Propositions are, therefore, restricted to surface clauses as defined by the overt presence of a verb. Apparently all more abstract levels of syntactic or semantic representation are not eligible as determiners of propositionhood in this system. For example, he explicitly states that "relationships between modifiers and their modified terms are not considered as separate clauses unless they appear as relative clauses." This rule seems fairly useful, in that it is not difficult to apply. However, Thorndyke does not always adhere to this rule in the analyses he proposes. For example, consider the following division:

> (1) Circle Island is located in the middle of the Atlantic Ocean, (2) north of Ronald Island.

Here the verbless phrase "north of Ronald Island" is treated as a separate proposition, despite the fact that in this system the presence of the verb is the crucial test of propositionhood.

Not only is the rule for dividing the ~~text~~ into propositions violated, as the example above shows; there is also evidence that no consistent method is applied. The analysis of "The Old Farmer and His Stubborn Donkey" contains a glaring inconsistency. Compare:

> (16) But the cat replied, "I would gladly scratch the dog,
>
> (17) if only you would get me some milk."

with

> (21) But the cow replied,
>
> (22) "I would gladly give you some milk
>
> (23) if only you would get me some hay."

These two examples are completely parallel in structure, but the first is analyzed as consisting of two propositions, while the second is supposed to have three.

Standards for Scoring Text Recalls and Summaries

The problems discussed above are two types: methods for dividing a text into components for scoring are not always made explicit, and when they are made explicit, they are not always adhered to. If an author's work is to be useful to other researchers, he or she must provide them with a description of how they too can carry out the research. This means that the scoring methods must be made explicit and they must be consistently followed. In keeping with this conclusion, we present here the standards that we used for dividing our texts into component propositions for the purposes of scoring summaries and recalls.

A proposition, for purposes of scoring, is defined as:

1. any clause/phrase containing a verb;
2. any gerund with at least one argument;
3. any postnominal modifier, including:
   a. relative clauses,
   b. prepositional phrases (except <u>of</u>-phrases),
   c. participial phrases,
   d. appositives,
   e. parentheses;
4. any reduced adverbial clause (subordinating conjunction + adjective);
5. any element joined to another element by conjunction (except for conjunctions of measurements);
6. only those prenominal modifiers which modify complements of a couplar verb or are members of a conjunction;
7. any adverb of manner or means.

These rules will produce more propositions than are strictly needed for separating the constituents. However, they provide a clear-cut surface-analyzable system which can be applied to a very shallow level in a mechanical way. It enables anyone to replicate our divisions.

We are far from satisfied that this is the most insightful way to divide the texts--in fact, we feel that any syntatic criteria will fall short of the mark. Using syntactic criteria fails to note redundancy across clauses and suggests that clausehood determines the weight of the content--it gives basically empty or weak clauses the same status as meaningful ones and implies that meaningful propositionhood is the same across text-types, which may, in fact, be untrue.

Here are the three short texts used in our experiments, divided up according to the above rules.

<u>Text 1 Story</u>

<u>The Dog and His Shadow</u>

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

Text 2 Instructions

Redistributing the Filler in a Sleeping Bag

1. One difficulty...(2,3,4)... is
2. with sleeping bags
3. in which down
4. and feather fillers are used as insulation
5. that this insulation has a tendency
6. to slip towards the bottom.
7. You can redistribute the filler?
8. The process is very simple.
9. Open the article
10. if possible.
11. Lay it on a hard surface,
12. such as the ground
13. or floor,
14. with the inside upwards.
15. Get a supple stick
16. about a yard long.
17. Then start beating the bag
18. lightly
19. from the foot up toward the top.
20. You will be able to feel
21. when a reasonably uniform thickness has been restored.
22. If necessary
23. turn the bag over
24. and go through the same process on the other side.

Text 3 Definition

The Immune System

1. The immune system is comparable...(2)...to the nervous system.
2. In the complexity of its functions
3. both systems are diffuse
4. organs
5. that are dispersed through most of the tissues of the body.
6. In man the imune system weighs about two pounds.
7. It consists of about a trillion cells
8. called lymphocytes
9. and about 100 million trillion molecules
10. called antibodies
11. that are produced
12. and secreted by the lymphocytes.
13. The special capability of the imnune system is pattern recognition
14. and its assignment is
15. to patrol the body
16. and guard its identity.

The following three sections of this paper present our analyses of the text structure of each of the three types of text studied. In addition, the relationships between the text structure of a text type and its typical text semantics are described. Finally, our analysis of the text structure and the semantics of each of the above short texts is presented as an example of its type.

Story Structure

Rules:

(1) STORY $\longrightarrow$ SETTING + PLOT

(2) PLOT $\longrightarrow$ PURPOSE + ATTEMPT* + OUTCOME

(3) PURPOSE $\longrightarrow \left\{ \begin{array}{l} \text{MOTIVE} \\ \text{PLOT} \end{array} \right\}$

(4) ATTEMPT $\longrightarrow \left\{ \begin{array}{l} \text{ACT* + RESULT} \\ \text{PLOT} \end{array} \right\}$

(5) RESULT $\longrightarrow$ (ATTEMPT) + OUTCOME

Terminal nodes:

SETTING:	Location of story in time and/or space and/or introduction of characters.
MOTIVE:	Desire or intent which motivates ATTEMPT(s).
ACT:	Action committed by some character which alone or in combination with other acts produces a consequence or elicits a reaction.
OUTCOME:	Action(s) and/or states which are the results of or a reaction to ACT(s) or ATTEMPT(s).

This structure is brief and simple; it consists of five rewrite rules and ten constituents--of which four are terminal elements. Nevertheless, it can be used to represent structures of infinite length and complexity. These rules can be used to produce specific trees to represent the structure of individual texts. The simplest tree these rules will produce is seen in Figure 5A. This tree is produced by realizing each constituent as a terminal node where that is possible; far more complex trees can be produced by using the recursive elements of the structure as seen in Figure 5B. A story structure generated by the above rules can be due to the application of recursive or iterative rules, or the structure can be quite simple.

Figures 6, (in text), 24 and 28 (in Appendix) present trees that represent the text structures of the three stories used as stimuli for our experiments. In the trees, the numbers represent the propositions. No attempt has been made to represent the dominance relationships among propositions which are dominated by the same terminal node. For example, one cannot discover merely by looking at these trees what the relationship is between two propositions subsumed under the same terminal node--they may be independent or one may be dependent on the other either semantically or syntactically. Our concern is with representing the relationships between and among constituents of texts, not constituents of sentences or even necessarily all the relationships that can hold between sentences.

A STORY consists of a SETTING and a PLOT. The SETTING serves to establish the background on which the PLOT operates. The PLOT consists of a PURPOSE and an ATTEMPT or series of ATTEMPTS to attain that PURPOSE (to carry out the stated or implied intent) ending in some final OUTCOME. The PURPOSE may consist of a plot which has its own PURPOSE, with the motive for the ATTEMPTS being established by the OUTCOME of that PLOT. ATTEMPTS may consist of ACTS and their RESULTS or of PLOTS (when some new subpurpose is being established). RESULTS consist of OUTCOMES (caused by ACTS) or of ATTEMPTS and OUTCOMES.

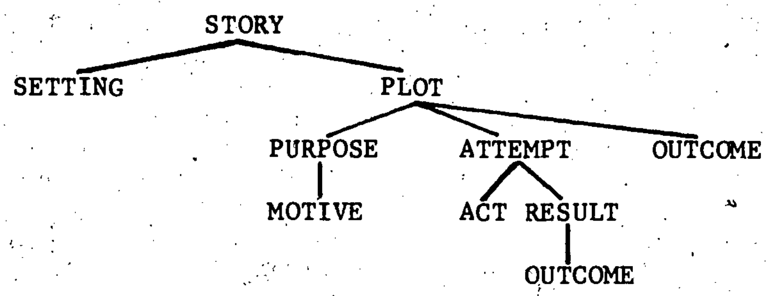


Figure 5A.

The Structure Of A Simple Story.

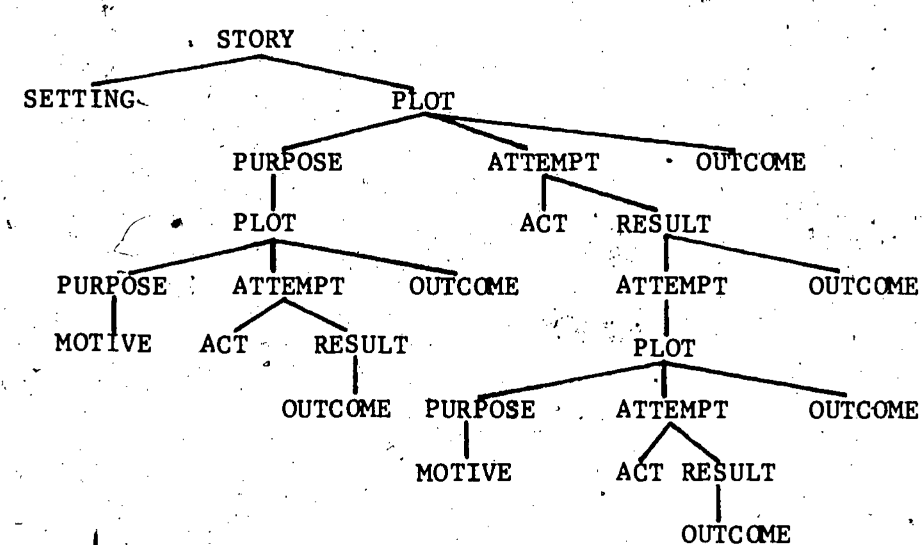


Figure 5B

The Structure Of A More Complex Story.

5?

To see how these rules work, consider the text presented on page 30 for the story "The Dog and His Shadow." In Figure 6 we can see the structural representation of this story:

(1) The SETTING ("It happened that a dog had got a piece of meat") introduces the characters, the dog and his meat.

(2) The MOTIVE (of the PLOT which forms the PURPOSE) ("and was taking it home in his mouth to eat.") states the dog's intentions which cause him to commit

(3) an ACT ("Now on his way home he had to cross a plank lying across a running brook. As he crossed,") This ACT enabled

(4) another ACT ("he looked down and saw his own shadow reflected in the water beneath.") which caused

(5) the OUTCOME ("Thinking it was another dog with another piece of meat,") which in turn causes the final

(6) OUTCOME of this PLOT ("he made up his mind to have that also.") This OUTCOME serves as the motive for the new ATTEMPT which begins with

(7) an ACT ("So he made a snap at the shadow, but as he opened his mouth") which had as its RESULT

(8) the OUTCOME ("the piece of meat fell out, dropped in the water,") which causes the final resolution of the PLOT,

(9) the OUTCOME ("and was never seen more.")

For each text, we have provided a semantic representation as well as a structural representation. These analyses are presented for each text which served as stimuli in our experiments. The semantic

"The Dog And His Shadow"

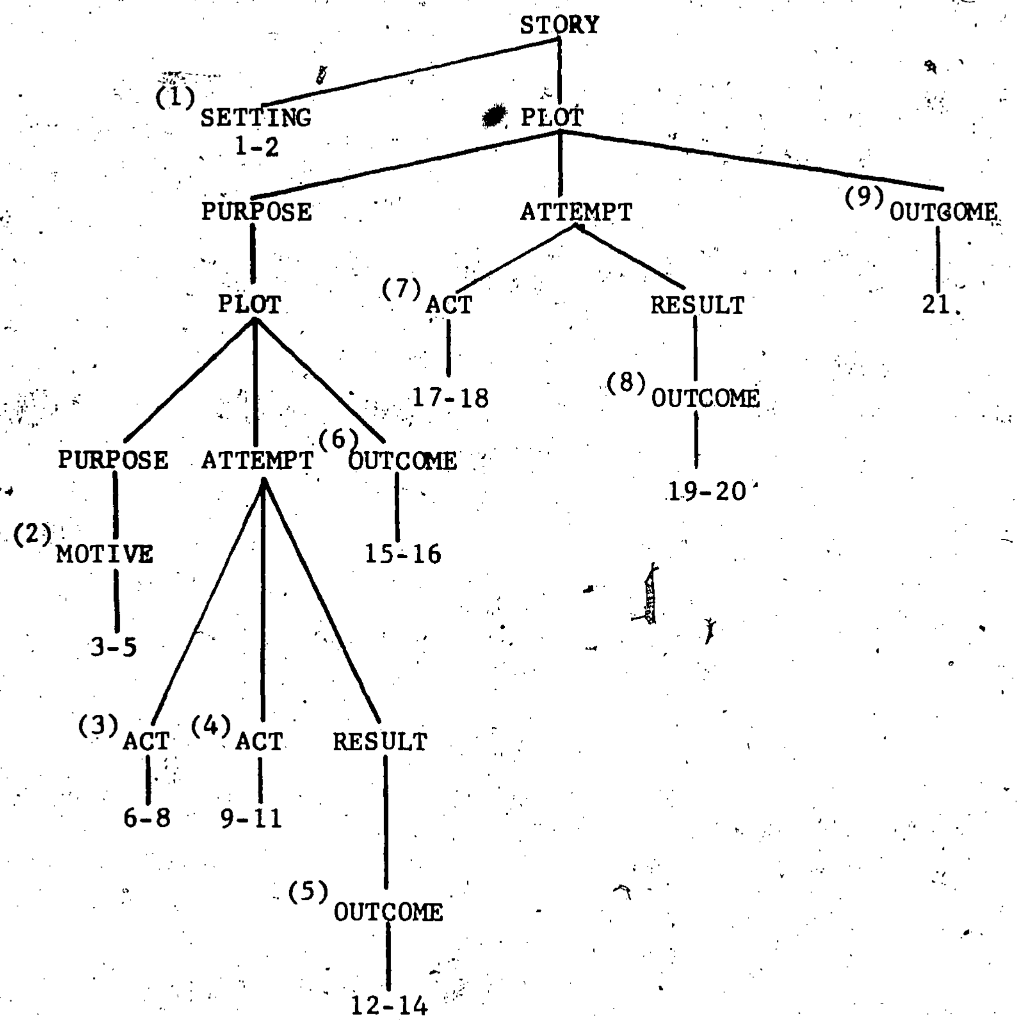


Figure 6.
The text structure of "The Dog and His Shadow"

The numbers in parentheses beside the terminal nodes refer to the numbers used in the discussion of this tree.

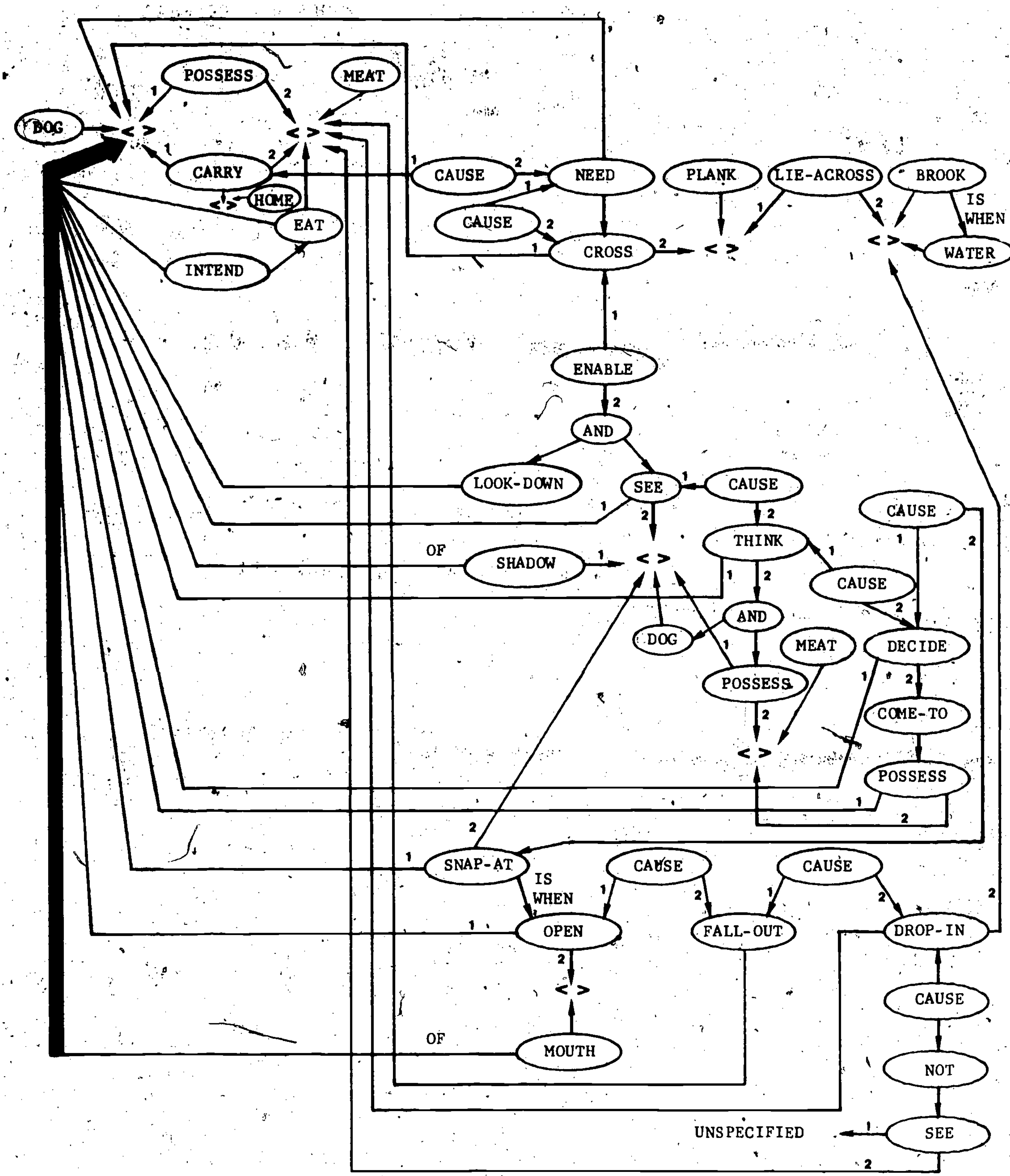


Figure 7. THE SEMANTICS OF A STORY: "THE DOG AND HIS SHADOW"

representation for "The Dog and His Shadow" is shown in Figure 7. The structural and semantic representations of "The Farmer and His Stubborn Donkey" are in Figures 24 and 25 (in Appendix), respectively; those for "Borrowing a Horse" are in Figure 28 and 29 (In Appendix).

In comparing the structure of stories and their semantics certain consistent and probably defining relationships can be observed. In order to discuss these relationships, we must define some terms which will enable us to talk about given parts of trees:

1. dominate: node A dominates node B, if A is higher in the tree and in a direct line with B, so in a tree

```
      X
    /   \
   Y     A
   |    / \
   Z   B   C
           |
           D
```

A dominates B,C,D, but not Y or Z.

2. immediately dominate: node A immediately dominates node B if A dominates B without any other node intervening, so if

```
   A
  / \
 B   C
```

, A immediately dominates B and C.

3. sister: Node A and node B are sisters if they are immediately dominated by the same node. So if

```
   X
  / \
 A   B
```

, A and B are sisters.

Aside from the particular events which occur within a particular story, a great many of the semantic relationships among and between those events are predictable on the basis of their text-type (story).

Here are the relationships that must hold among the constituents of a story: 1. The MOTIVE causes the first ACTs which are immediately dominated by the ATTEMPTs which are sisters of the PURPOSE which immediately dominates that MOTIVE. (See Figure 8A).

2. The MOTIVE causes the leftmost MOTIVEs of those ATTEMPTs that are realized as PLOTs and that are sisters of the PURPOSE which immediately dominates the MOTIVE (See Figure 8B).

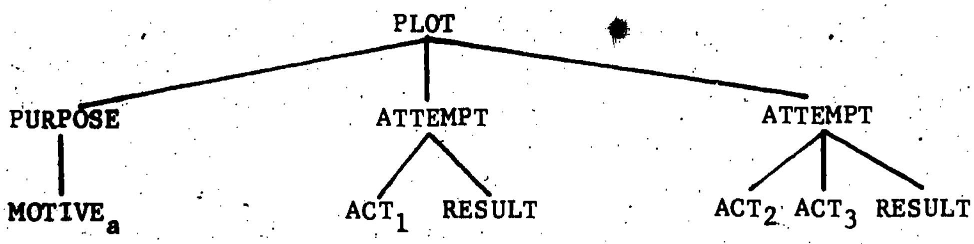
3. An ACT causes or enables the OUTCOME immediately dominated by its sister RESULT. (See Figure 8C).

4. If a RESULT also dominates an ATTEMPT, the ACT which is sister to the RESULT causes or enables any ACTs dominated by the ATTEMPT and also causes or enables the OUTCOME. (See Figure 8D).

5. If a PURPOSE is realized by a PLOT, its OUTCOME bears the same relationships that a MOTIVE would bear. (See semantic rules 1 and 2).

6. In any sequence of OUTCOMEs, the left OUTCOME causes or enables the OUTCOME to its immediate right. (See Figure 8E).

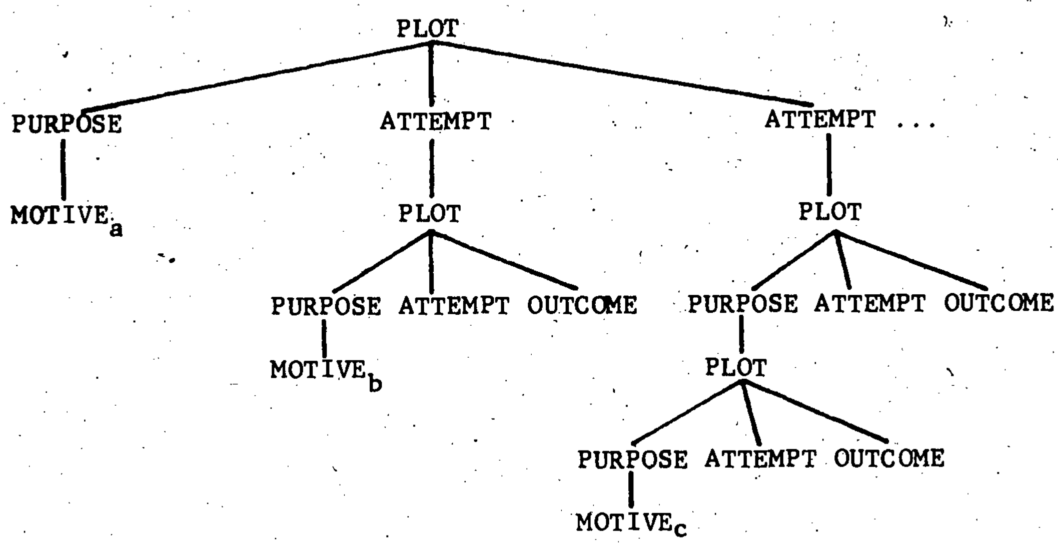
Other relationships may hold among constituents, but these are not obligatory. For example, there may be an enabling relationship between ACTs immediately dominated by the same ATTEMPT, but this relationship does not have to hold.



MOTIVE$_a$ causes ACT$_1$ and ACT$_2$.

Figure 8A.

The causal relationship between MOTIVEs and certain ACTs.

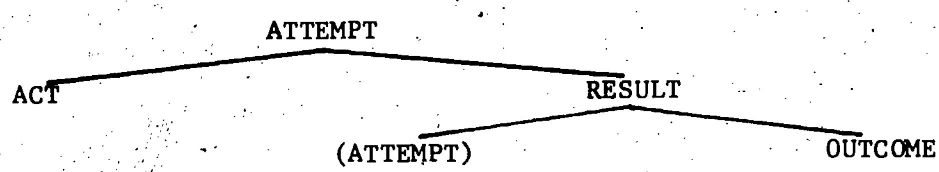


MOTIVE$_a$ causes MOTIVE$_b$ and MOTIVE$_c$.

Figure 8B.

The causal relationships between certain MOTIVEs:

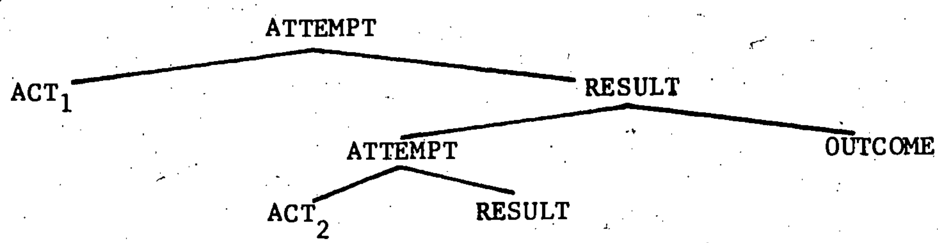
Figures 8A and 8B.



ACT causes or enables OUTCOME.

Figure 8C.

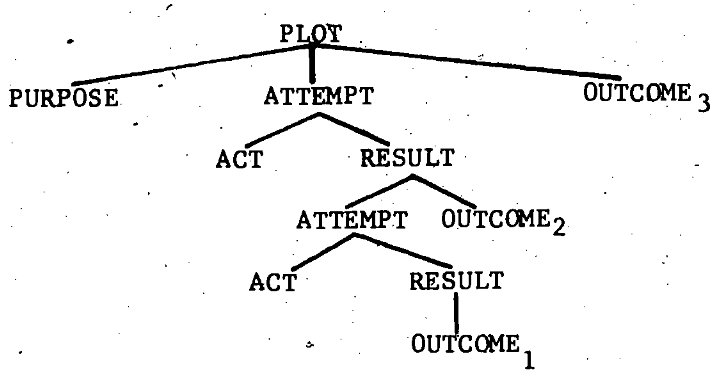
The causal or enabling relationship between some ACTs and OUTCOMEs.



ACT_1 causes or enables ACT_2 and OUTCOME.

Figure 8D.

The Causal or Enabling Relationship Among Certain Other ACTs.



$OUTCOME_1$ causes or enables $OUTCOME_2$ which causes or enables $OUTCOME_3$.

Figure 8E.

Causal or Enabling Relationships Among Certain OUTCOMEs.

Figures 8C, 8D, and 8E.

Instruction Structure

Rules:

(1) $$\text{INSTRUCTIONS} \longrightarrow \text{GOAL} + \text{DIRECTIONS} + \left(\begin{Bmatrix} \text{GOAL} \\ \text{MOTIVE} \end{Bmatrix} \right)$$

(2) GOAL ⟶ PRODUCT + (MOTIVE)

(3) DIRECTIONS ⟶ (PREPARATION) + MAIN-SEQUENCE

(4) PREPARATION ⟶ (MATERIAL) + STEP*

(5) MAIN-SEQUENCE ⟶ STEP*

(6) $$\text{STEP} \longrightarrow \begin{Bmatrix} \text{STEP*} \\ \\ \text{STEP} + \begin{Bmatrix} \text{CHECK} \\ \text{RESULT} \\ \text{PURPOSE} \\ \text{REPEAT} \end{Bmatrix} \\ \\ \text{CONDITION} \end{Bmatrix}$$

Terminal nodes:

MOTIVE: encouragement to follow DIRECTIONS; statements about simplicity, interest, cheapness, etc., of process and/or product.

PRODUCT: description of intended outcome.

MATERIAL: statement of major equipment/constituents of process.

CHECK: instruction to examine result of some act/process and compare it to some stated or implied goal or standard.

RESULT: predicted side effect of committing some act(s).

REPEAT: instruction to return to STEP immediately dominated by STEP which immediately dominates REPEAT and repeat process from there. (This may include some prerequisite STEP(s).)

CONDITION: any act, state or process which must be accomplished or obtained in order to complete some portion of a prescription.

PURPOSE: main and predicted outcome of committing some act(s).

INSTRUCTIONS are made up of a GOAL and the DIRECTIONS for attaining that GOAL. The GOAL itself consists of a description of the output of following the DIRECTIONS, the PRODUCT, and optionally some encouragement to attempt the process, the MOTIVE. After the DIRECTIONS, the prescription may optionally restate the GOAL or give some MOTIVE. The DIRECTIONS may include a PREPARATION and always includes a MAIN-SEQUENCE of instructions which serves to describe the central act(s) of the prescription. The PREPARATION consists of an optional MATERIAL constituent and some STEP (or STEPs). MATERIAL describes the major ingredients or equipment of the process. The STEPs express the preparatory acts which must be accomplished to enable one to carry out the MAIN-SEQUENCE. The MAIN-SEQUENCE also consists of a sequence of STEPs. These STEPs consist of the statement of an act which must be performed, a state which must obtain or a process which must be undergone--a CONDITION which must be met (in other words). A STEP may consist of a STEP and some special kind of instruction (which must be associated with a STEP, like CHECK or REPEAT, or a STEP and some explanatory or descriptive material like PURPOSE or RESULT).

The structural and semantic representations of the INSTRUCTIONS which served as experimental stimuli ("Redistributing the Filler in a Sleeping Bag" and "Making a Concrete Planter") are provided in Figures 9 and 10 (in text), 31 and 32 (in Appendix). Again we can see that there is a relationships between the structures and the semantics which can be expressed in rules:

1. The PREPARATION enables the first STEP of the MAIN-SEQUENCE.
2. STEPs enable their sister CHECKs and cause their sister REPEATs.
3. STEPs cause their sister RESULTs.

Redistributing the Filler In a Sleeping Bag"

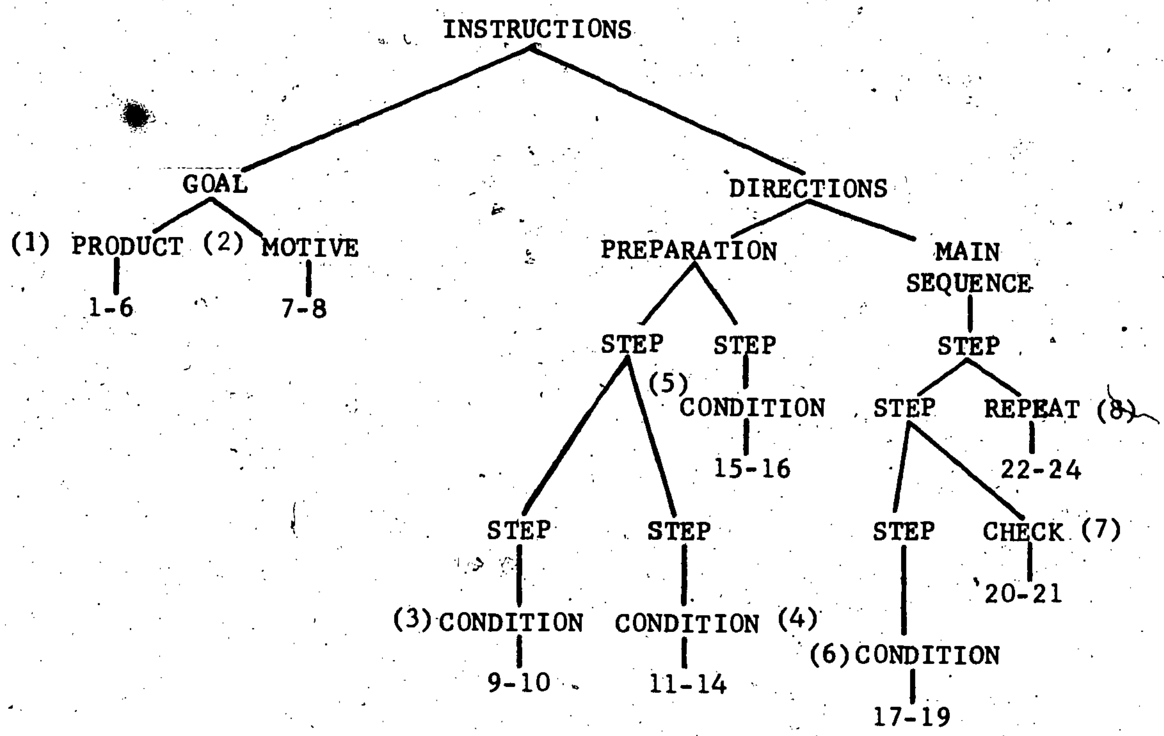


Figure 9.

The text structure for "Redistributing the Filler In a Sleeping Bag."

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```
SLEEPING-BAG (x)
        is when
INSULATION (of x, AND (DOWN-FILLER, FEATHER-FILLER))
TROUBLE (with x, TEND (INSULATION (x), SLIP (INSULATION (x)), to BOTTOM (x)))
POSSIBLE (REDISTRIBUTE (ACTOR, FILLER (x)))
EASY (REDISTRIBUTE (ACTOR, FILLER (x)))

REDISTRIBUTE-BAG (ACTOR, FILLER (SLEEPING-BAG))
        is when
PREPARE-BAG (ACTOR, SLEEPING-BAG)
PREPARE-STICK (ACTOR, STICK)
ENABLE (AND (PREPARE-BAG (ACTOR, SLEEPING-BAG), PREPARE-STICK (ACTOR, STICK)),
   START (BEAT-BAG (ACTOR, SLEEPING-BAG)))
BEAT-BAG (ACTOR, SLEEPING-BAG)
IF (NOT (RESTORE (BEAT-BAG (ACTOR, SLEEPING-BAG), to UNIFORM-THICKNESS (SLEEPING-
   BAG))),
   then AND (TURN (ACTOR, SLEEPING-BAG), REPEAT (BEAT-BAG (ACTOR, SLEEPING-BAG)))

PREPARE-BAG (ACTOR, SLEEPING-BAG)
        is when
IF (POSSIBLE (OPEN (ACTOR, SLEEPING-BAG)), then OPEN (ACTOR, SLEEPING-BAG))
LAY-ON (ACTOR, SLEEPING-BAG (INSIDE-UPWARDS (SLEEPING-BAG)), HARD-SURFACE)

HARD-SURFACE (x)
        is when
...
EXAMPLE (x, OR (GROUND, FLOOR))

PREPARE-STICK (ACTOR, STICK)
        is when
GET (ACTOR, STICK)
SUPPLE (STICK)
LENGTH (STICK, 1-YARD)

BEAT-BAG (ACTOR, SLEEPING-BAG)
        is when
USE (ACTOR, STICK, BEAT (ACTOR, SLEEPING-BAG))
LIGHT (BEAT (ACTOR, SLEEPING-BAG))
FROM-TOWARD (BEAT (ACTOR, SLEEPING-BAG), BOTTOM(SLEEPING-BAG), TOP (SLEEPING-
   BAG))
ENABLE (BEAT (ACTOR, SLEEPING-BAG), FEEL (ACTOR, RESTORE (BEAT (ACTOR,
   SLEEPING-BAG), UNIFORM-THICKNESS(SLEEPING-BAG))))
FEEL (ACTOR, RESTORE (BEAT (ACTOR, SLEEPING-BAG), UNIFORM-THICKNESS
   (SLEEPING-BAG)))
```

Figure 10. The text semantics for "Redistributing the Filler in a Sleeping Bag"

4. PURPOSEs activate their sister STEPs as subschemata.

5. A STEP enables the sister STEP to its immediate right, when they are immediately dominated by STEP.

Other types of semantic relationships among the major components of instructional texts are also possible, of course. However, the semantic relationships shown here should always be expected.

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Definition Structure

Rules:

(1) DEFINITION → CHARACTERISTIC*

(2) CHARACTERISTIC → { TRAIT / DEFINITION }

Terminal nodes:

TRAIT: specification of some concept/entity being defined; typically expressing such information as:

- components
- participants
- effects/manifestations
- functions
- physical attributes-- size, shape, color, texture, etc.
- location
- types
- creators
- habits
- source
- abilities
- time

A DEFINITION of some concept or entity consists of some CHARACTERISTICs which are themselves defining TRAITs or which are DEFINITIONs of something else which is a CHARACTERISTIC of the concept or entity. Thus, in defining a square, one can say:

1. it is a geometric shape.
2. it is formed by four straight lines.
3. these lines meet at right angles.

These are CHARACTERISTICs, TRAITs.

One can further say of right angles:

4. a right angle is an angle of 90°.
5. lines which meet at right angles are said to be perpendicular to each other.

These are also TRAITs, TRAITs of a right angle which is itself a TRAIT of squares. Lines 1 - 5 constitute a definition of a square with an embedded definition of right angle.

The semantic representations given below (in Figures 12 (in text), 36, and 40 (in Appendix) reflect the flatness of the corresponding structure representations of these definitions (shown in Figures 11 (in text), 35 and 39 (in Appendix). TRAITs are not causally or enablingly linked. Instead, they are grouped by sharing arguments. The DEFINITIONs within a DEFINITION refer to each other or to the dominating DEFINITION by sharing or overlapping arguments or propositions. The TRAITs of a single DEFINITION are connected by shared arguments not by higher predicates.

"The Immune System"

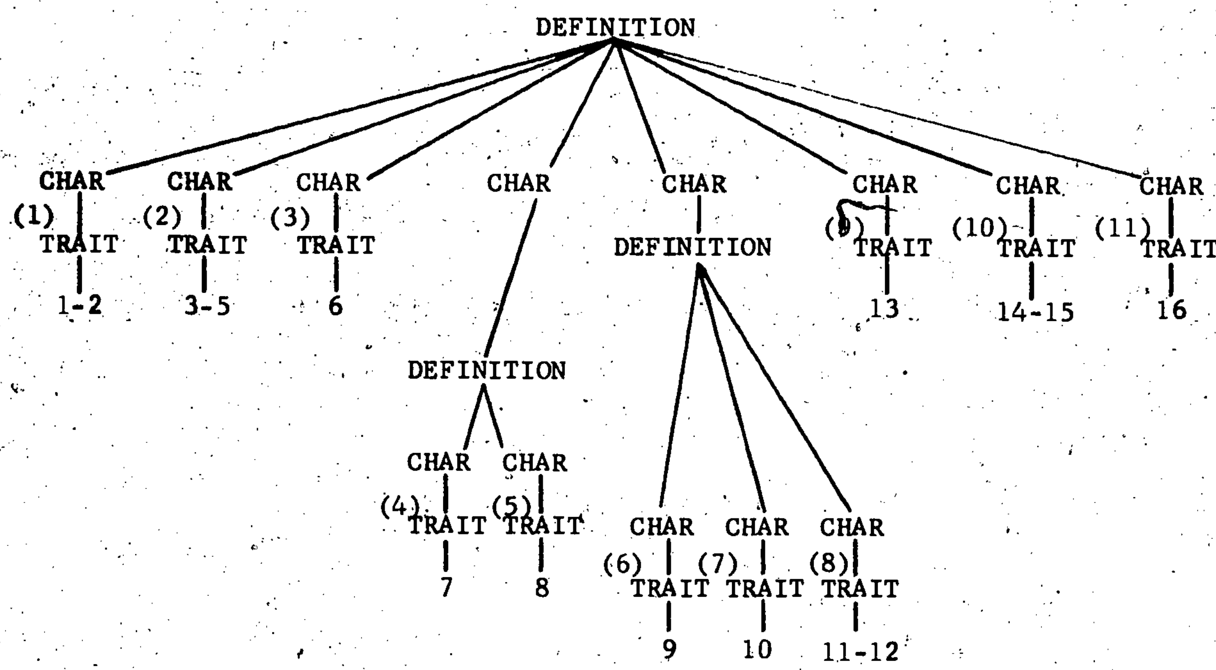

Figure 11.

The structure of "The Immune System."

Note: CHAR = CHARACTERISTIC.

IMMUNE-SYSTEM (x)
is when
COMPARABLE (COMPLEXITY (FUNCTIONS (x)), COMPLEXITY (FUNCTIONS (NERVOUS-SYSTEM)))
DIFFUSE-ORGAN (AND (x, NERVOUS-SYSTEM))
DISPERSED-THROUGH (AND (x, NERVOUS-SYSTEM), TISSUES (BODY))
WEIGH (x, 2-LBS.)
CONSIST-OF (x, AND (LYMPHOCYTES, ANTIBODIES))
RECOGNIZE (x, PATTERNS)
PATROL (x, BODY)
GUARD (x, IDENTITY (BODY))

LYMPHOCYTES (x)
is when
CONSIST-OF (IMMUNE SYSTEM, AND (x, ANTIBODIES))
CELLS (x)
NUMBER (of x (IN (x, BODY)), TRILLION)
PRODUCE (x, ANTIBODIES)
SECRETE (x, ANTIBODIES)

ANTIBODIES (x)
is when
CONSIST-OF (IMMUNE SYSTEM, AND (LYMPHOCYTES, x))
MOLECULES (x)
NUMBER (of x (IN (x, BODY)), 100-MILLION-TRILLION)
PRODUCE (LYMPHOCYTES, x)
SECRETE (LYMPHOCYTES, x)

Figure 12. The Semantics of "The Immune System."

We have explicated a model of the differences in text structure and in text semantics for three types of texts. Other systematic differences among texts of different types can also be observed. There are lexical and grammatical differences which are closely linked to the pragmatic qualities of each text-type. A simple, transparent example of this kind of difference can be seen by examining the types of sentences which appear in our example texts:

> around 1/2 of the sentences which appear in the instructions are imperatives as compared with no (0) imperatives in the other 2 text-types.

Certainly the reason for this distinction is intuitively obvious (given the intent of the texts) and form some part of our expectations as to text-type. Text-types differ in complexity of sentences, number of different types of words (part of speech and type token ratios for nouns, verbs, etc.), and in many other particulars. We believe that to try to control all the differences except those due to differences in text structure and text semantics is probably futile; any such attempt would alter the type of text itself. The least dangerous (and most natural) basis for getting comparable texts of different types is to choose texts with the same number of words or, perhaps, the same number of propositions.

IV. EXPERIMENTS[2]

We have proposed that there are regular and describable differences between texts of different types. We have presented representations of these differences (structural and semantic) for three different text-types and for eight individual texts which are members of these types.

Earlier experiments designed to test theories of text-structure and text semantics are of two types: summarization and recall. Rumelhart (in press) used his analysis of stories to predict the structure of summaries. He claimed that his "representation of the structure of a story gives us a distinction between the important parts of a story and the details. In general, the higher the information in the structure diagram, the more central to the story and the lower the information the more peripheral." In theory, then, if a summary is a recapitulation of the most important information in a text, its structure can be mechanically predicted from the structure diagram of the text. In addition to defining importance in terms of position in the diagram, Rumelhart proposed a set of summarization rules which collapse nodes into their most "important" parts--those which "state, as succinctly as possible, the central ideas of the schema named by that node." This attractive theory claims that the structure of a text reflects the importance of the elements within the text and that summarization provides access to people's judgements about the importance of the parts of a text.

Recall data has also been used to get at these elements of structure and semantics. In our view, during the presentation of a text, each reader experiences the activation of a variety of schemata, with the result that

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[2] We thank David Werner for his assistance in the preparation of this section.

both a text structure and a text semantics representation play a role in his or her understanding of the text. We expect the text structure representation to decay rapidly after the end of the text presentation; we believe that the primary function of a text structure is to aid in the construction of a text semantics. At the time of the recall task, we expect subjects to use their semantic representations of the text in conjunction with what fragments of specific text structure representation remained in memory and an activation of a generic text-type schema to reconstruct a version of the text. This model, together with several plausible assumptions, enables us to make some predictions about the nature of what readers recall from different texts.

Two assumptions are required to make predictions about the nature of recall for different text-types. First, we assume that the process of storing new information in memory is more straight-forward (or simpler) for specific concepts that for generic concepts. Second, we assume that retrieval is easier when information is hierarchically arranged than when it is organized in linear fashion.

The texts used in the present study differ markedly along the genericness-specificity dimension and the hierarchical-linear organization dimension. Stories convey specific information. (See the specific semantic representations in Figures 7, 25 and 29). They are also characterized by deep hierarchical structures as can be seen in the structural representations given for the stories. (See Figures 6, 24, and 28). On the other hand, definitions convey generic information (the semantic representations in Figures 12, 36 and 40 are in generic schema format) and are characterized by flat, non-hierarchical text-structures (as can be seen in Figures 11, 35 and 39). Instructions are in some ways similar to definitions and in other ways similar to stories. Like definitions, they convey generic information. (See Figures 10 and 32). However, they also possess a hierarchical text structure characteristic of stories. (See Figures 9 and 31).

If our earlier assumptions are correct, then information in stories should be easier to store than information in definitions or instructions. Furthermore,information retrieval should be easier for stories and instructions than for definitions. We should therefore predict that recall for story texts will exceed recall for instruction texts, which in turn should be better than recall for definitional texts. We predict that texts of the same type will be recalled equally well regardless of their semantic content, if in fact structural factors alone determine recall. In order to test this prediction, two passages of each text type were developed that varied in length--long and short. The longer texts are more than twice as long as the short texts in number of propositions and terminal nodes.

These predictions relate to the sheer quantity of information that will be recalled for the various types of texts. A different type of prediction is that text-type affects not only the amount recalled but also what is recalled. Texts should not be recalled like lists of unrelated items, where serial order plays a major role. We would expect the hierarchical relationships to determine what is recalled in texts. In definitions, however, where the hieararchical structure is minimal, linear order should play a more critical role, although we do not expect the pattern of a classical serial position curve since this material is semantically organized. We expect to be able to determine which elements of a text are more or less likely to be recalled for each text-type.

Experiment 1

In the first experiment, we had students summarize and recall texts of different types. We decided to have the students summarize the texts to test the extent to which their summaries reflect the "importance" of the content. We believe that some parts of text structures are more important than others and are, therefore, more likely to be included in the summaries. On the basis of such an assumption, we predict that text-type will play a role in determining which parts of the passage will be included in the summaries. One of the texts used in the experiment is a story that Rumelhart used in his summarization experiment. It is included to see how closely the summaries generated by our subjects match those produced by his subjects.

In addition to writing summaries, students are also required to recall half of the texts that they summarize to see how well (or poorly) the recalls match our predictions for the memorability of texts of different types.

Method

Eighteen undergraduate college students chose to participate in this experiment for credit in an introductory psychology class. Four college graduate students also participated in the study for a total sample size of 22 subjects.

Students were tested in groups of two to four. Each student was ramdomly assigned to one of four treatment groups that differed according to the order in which the six texts were presented. The two between-subjects factors related to order are length order (short-long versus long-short) and text-type order (definition-story-intruction versus instruction-story-definition). The four resultant treatment groups are:

1. long definition, long story, long instructions, short definition, short story, short instructions;

2. short definition, short story, short instructions, long definition, long story, long instructions;

3. long instructions, long story, long definition, short instructions, short story, short definition; and

4. short instructions, short story, short definition, long instructions, long story, long definition.

For comparing the students' summaries, the design is a 2 x 2 x 3 x 2 factorial with repeated measures on the last two factors. The two between-subjects factors are length order and text-type order as described above, while the two within-subjects factors are text type (story, instructions, and definition) and text length (short and long). For comparing the students' recalls, the design is a 2 x 2 x 3 factorial with repeated measures on the last factor of text type. Since the students recall only the first three texts, the previously within-subjects factor of text length order is one of the between-subjects factors.

Each student was given three booklets during the course of the experiment: a text booklet, a summary booklet, and a recall booklet. Each will be described in turn. The text booklet consisted of an instruction sheet and six typed passages, titled as follows:

"Redistributing the Filler in a Sleeping Bag"	(short instructions)
"The Dog and his Shadow"	(short story)
"Immune System"	(short definition)
"Making a Concrete Planter"	(long instructions)
"The Old Farmer and his Stubborn Donkey"	(long story)
"Nematodes"	(long definition)

Along with the text booklet, the students received a summary booklet. It consisted of a blank cover and blank pages, each headed by a title of one of the passages. (The order of these pages agreed with the order of texts in the text booklet.) The students were asked to write short summaries of each of the six texts. They were asked not to look back at any text once they had gone on to the next text. They were given unlimited time. Upon completion of the task, they were asked to give their booklets to the experimenter.

After turning in the text booklet, each student was moved to another room and given a recall booklet. This booklet consisted of an instruction sheet and three blank pages, headed by the titles of the first three texts presented in the text booklet. The students were asked to recall each text as nearly verbatim as they could. They were told to be as exact and complete as possible. This recall phase was not expected by the students and unlimited time was permitted.

Results and Discussion

Scoring the Summaries. Following his model of summarization, Rumelhart (in press) used summary data to support his analyis of problem-solving narratives. Using this schemata and rules, he predicted several levels of summarization for four brief stories, including "The Dog and his Shadow." He then had subjects summarize the stories and he compared their summaries with what he had predicted. For his subjects he found a good fit with his predictions. For our students, the fit was not as good. There were some theoretical and operational problems in trying to apply Rumelhart's system.

Rumelhart's summarization predictions were based on his structure diagrams which presented specific instances of this "problem solving schema." This schema represents only problem-solving episodes, not whole stories, and represents the constituent relations of these episodes at the same level as the semantic relations between the constituents (unlike his earlier representation). To these structure diagrams, he applied summarization formulae, rules which produce a summary from the diagram of the structure of the original text.

Since rules like Rumelhart's summarization formulae do not apply well to our representation, we developed a related, but somewhat different, set of rules. Our procedures are described in the section entitled "Standards for Scoring Text Recalls and Summaries." Our analysis attempts to represent whole stories and other kinds of texts as well, but it does not attempt to represent the constituent relations and the semantic relations between the constituents at the same level.

Analysis of Summaries. Two types of data were examined for each passage summarized by the students. The number of propositions and the number of terminal nodes from the text that the student included in the summary were determined. Using the propositional analysis described earlier, each summary was scored for the number of propositions included. Each such score was then converted into a ratio of the number of propositions included in the summary to the total number of propositions in the text passage. The means of the students' ratio scores for each passages are shown in Table 1a.

The second type of data on students' summaries was obtained by scoring each summary for the presence or absence of terminal nodes of the text structure for each text. Again, each student's score was converted into a ratio of the number of terminal nodes that were included in the summary to the total number of terminal nodes present in the text passage. The means of the students' ratio scores for terminal nodes of each passage are shown in Table 1b. (See sections "Story Structure," "Instruction Structure"

Table 1a. Mean Percent of Propositions

Included in the Summaries

Group	n		Short Story	Short Instructions	Short Definition	Long Story	Long Instructions	Long Definition
1	5	$\bar{X}$	34.26	33.32	33.78	22.94	26.00	39.96
		SD	(10.34)	(12.86)	(24.44)	(20.78)	(24.80)	(29.30)
2	6	$\bar{X}$	46.03	45.83	42.73	35.78	33.00	40.67
		SD	(28.36)	(21.74)	(23.52)	(26.17)	(26.47)	(29.58)
3	6	$\bar{X}$	40.47	47.92	45.87	31.32	30.20	46.50
		SD	(19.21)	(18.78)	(33.72)	(21.84)	(18.10)	(24.48)
4	5	$\bar{X}$	41.90	25.84	43.76	15.10	17.72	28.34
		SD	(29.04)	(9.48)	(17.69)	(15.18)	(14.55)	(17.83)

Table 1b. Mean Percent of Terminal

Nodes Included in the Summaries

Group	n		Short Story	Short Instructions	Short Definition	Long Story	Long Instructions	Long Definition
1	5	$\bar{X}$	51.12	65.00	60.00	30.00	35.82	39.24
		SD	(12.70)	(25.62)	(32.51)	(25.05)	(35.53)	(26.92)
2	6	$\bar{X}$	61.12	70.83	50.02	54.87	54.15	54.93
		SD	(36.36)	(24.58)	(26.17)	(34.51)	(34.46)	(34.56)
3	6	$\bar{X}$	59.27	72.92	53.03	41.67	39.58	51.37
		SD	(26.93)	(18.40)	(37.43)	(23.59)	(26.96)	(23.34)
4	5	$\bar{X}$	57.78	45.00	61.82	27.52	22.52	46.92
		SD	(38.01)	(16.77)	(24.37)	(22.55)	(20.12)	(32.68)

Note. See page 56 for meaning of treatment group numbers.

and "Definition Structure" above for a discussion of terminal nodes.) A given terminal node can be represented in the text by one or more propositions. When more than one proposition was part of a terminal node in a stimulus text, we scored that node as present if any of the propositions of that node were in the summary.

The analysis of variance performed with data on student summaries revealed only one main effect for the within-subject factor of text length and no interactions. Length of the stimulus text affected the proportion of terminal nodes in the summaries, $F\ (1,18) = 14.45$, $p < .005$. Text length did not, however, significantly affect the proportion of propositions included in the summaries although the means vary in the same direction as those of terminal nodes, $F\ (1,18) = 6.43$, NS. Examination of the means in Tables 1a and 1b indicates that long text passages resulted in lower proportion of information included from the summaries than did short passages. This result is plausible if we assume that students tend to produce summaries of similar length regardless of the length of the passage being summarized. As text length increases and summary length remains approximately the same, the proportion of information elements included in the summary to total possible elements in the passage decreases. Therefore, the factor of text length is inversely related to the ratio of summary information to total information in the text. The other factors, including the two ordering variables and the text type variable, did not affect the proportionate amount of information included in the students' summaries.

It is not enough to ask how much information (proportionately) is included in the summaries. We are also interested in what information is included in the student's summaries, an issue that Rumelhart (in press-a) addressed as well. We were interested in determining if some terminal nodes were more often included in the summaries than other terminal nodes. To test the null hypothesis that all terminal nodes appeared in the summaries with equal frequency, a repeated measures ANOVA was conducted for each passage to compare the percentage of students who included each node. As in all other analyses reported here, the rather stringent alpha level of .005 was adopted for the significance tests so as to reduce Type I error that could occur due to our numerous tests. The results of the six analyses are summarized in Table 2 and indicate that terminal nodes are not equally present in the students' summaries. For the short passages, these differences in terminal node inclusion are graphically presented in Figures 13, 14, and 15. The graphic presentations of this data for the long passages are included in the Appendix in Figures 26, 33, and 37.

Examining the figures, we can see that certain terminal nodes are often included while other nodes are typically omitted. In "The Dog and His Shadow," terminal nodes 2, 4, 7 and 8 are usually included in the summaries. These terminal nodes are the MOTIVE (2), non-final ACTs (4 & 7) and the OUTCOME (8) which first resolves the entire plot. Terminal node 1 (SETTING) and terminal nodes 9 (OUTCOME) (which is redundant with 8) are usually omitted.

In the "Old Farmer and His Stubborn Donkey," the terminal nodes usually included are 2 (the first MOTIVE), and 4 (the final OUTCOME); the terminal nodes usually omitted include 1 (SETTING), 3, 5, and 6 (fruitless ACTs and their RESULT), 10 (embedded MOTIVE).

In both stories, the SETTING tends to be omitted in summaries; the first MOTIVE is included; and the first resolution of the entire plot the OUTCOME, is included. To substantiate this result for stories

Table 2. Summary of Repeated Measure ANOVAs for Inclusion of Terminal Nodes in Summaries

Text	Number of Terminal Nodes	F ratio
The Dog and His Shadow	9	7.62*
Redistributing the Filler	8	7.83*
Immune System	11	2.87*
The Old Farmer	24	11.27*
Making a Concrete Planter	24	3.51*
Nematodes	27	3.26*

Note. N = 22 for each analysis.

* $p < .005$.

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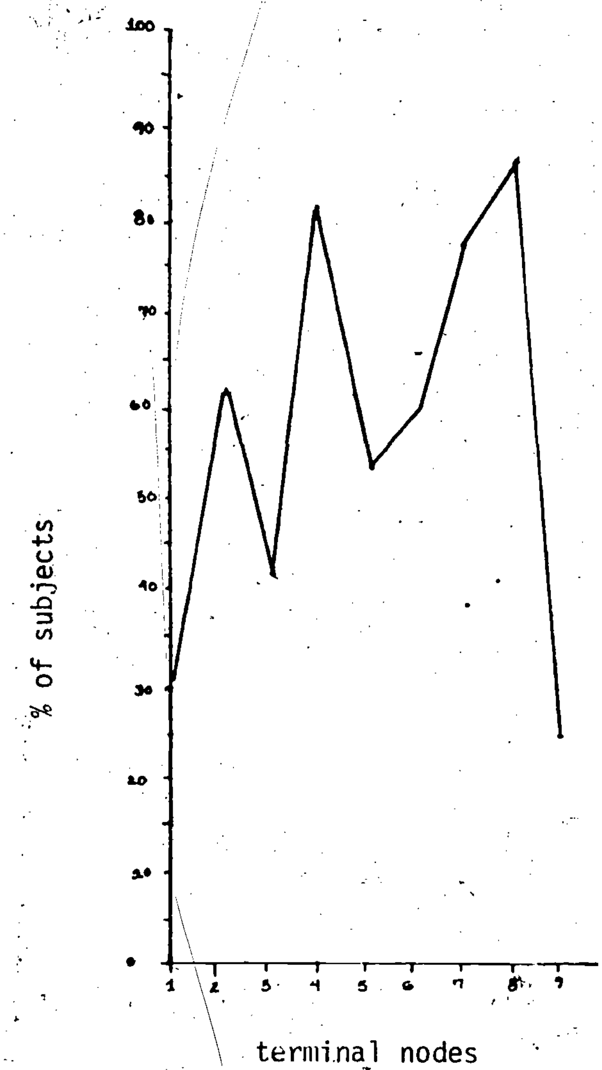

Fig. 13: Percent Subjects Who Included Terminal Nodes in Summary of "The Dog and his Shadow" (Short Story)

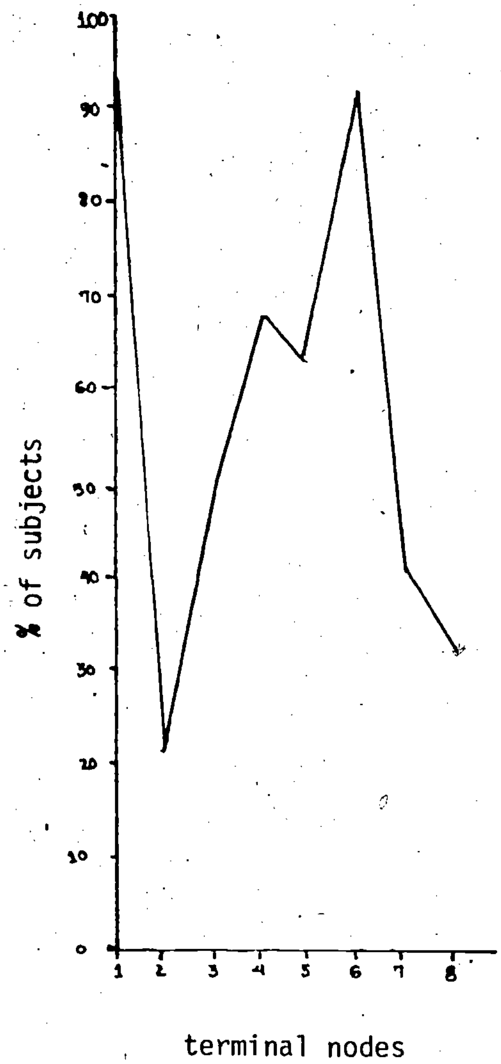

Fig. 14: Percent Subjects Who Included Terminal Nodes in Summary of "Redistributing the Filler in a Sleeping Bag" (Short Instructions)

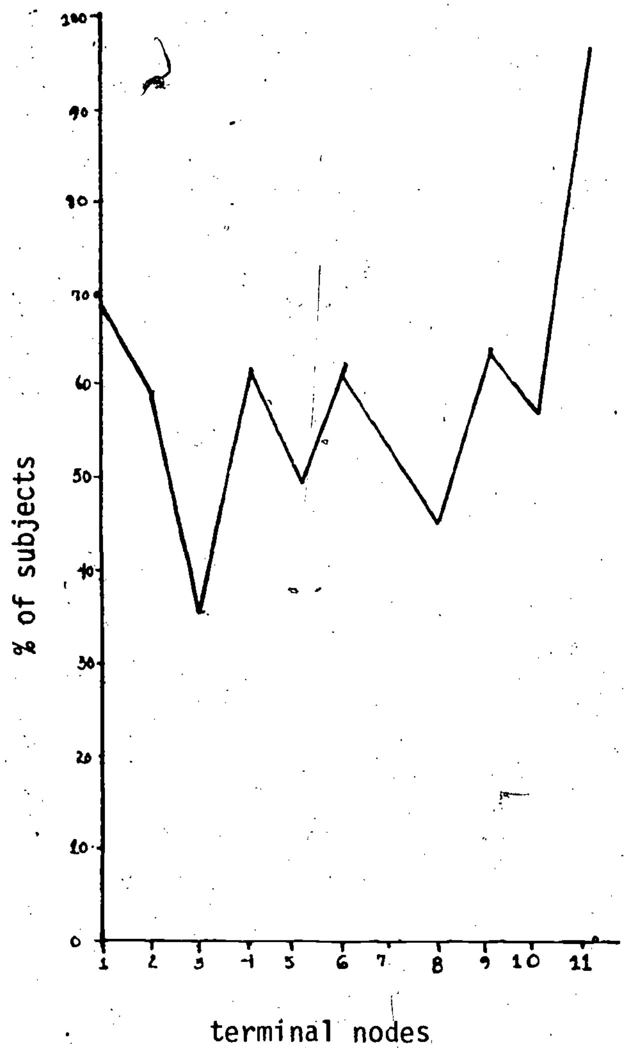

Fig. 15: Percent Subjects Who Included Terminal Nodes in Summary of "Immune System" (Short Definition)

in general, one would have to obtain summary data for a larger number of story texts, and analyze the data with an F' test (Clark, 1973).

Both instructions tend to have the first CONDITION of their MAIN-SEQUENCE included in the summaries, corresponding to terminal node 6 in "Redistributing the Filler in a Sleeping Bag" and terminal node 10 in "Making a Concrete Planter."

In definitions, the first TRAIT and the last TRAIT tend to be included in the summaries (in "Nematodes" terminal node 2 is center-embedded in terminal node 1, in linear order the predicate of 2 precedes that of 1).

Some predictions can be made about which elements of a text are more likely to show up in summaries of that text. All the elements cannot be rated this way, nor will these predictions hold true for every individual summary. Far more texts would have to be tested for these results to be more than merely suggestive.

Analysis of Recalls. For the three texts recalled by each student, the percent propositions and percent terminal nodes included in the free recalls were calculated. Using these percentages as the two dependent variables, we performed two 2 X 2 X 3 ANOVAs with the two between-subjects factors being text length (short versus long) and text-type order and the within-subjects factor being the three types of text. The results of these analyses are presented in Tables 3a and 3b, indicating that the factor of text length affected percent propositions recalled. Also, as predicted, text type affected recall of both terminal nodes and propositions. No other main effects or interactions were significant. Since the order of text presentation did not affect recall, the mean percentages of propositions and terminal nodes recalled were collapsed across the two levels of order.

Table 3a. ANOVA Summary Table for Percent of Propositions Recalled.

Source	df	Mean Square	F ratio
Between Subjects			
Length	1	5662.75	10.42*
Order	1	174.32	.32
Length x Order Interaction	1	3053.61	5.62
Error	18	543.41	
Within Subjects			
Text Type	2	2571.76	10.33*
Type x Length Interaction	2	28.63	.11
Type x Order Interaction	2	298.92	1.20
Type x Length x Order	2	91.75	.37
Error	36	248.96	

*$p < .005$.

Table 3b. ANOVA Summary Table for Percent of Terminal Nodes Recalled

Source	df	Mean Square	F ratio
Between Subjects			
Length	1	7627.83	9.81
Order	1	386.95	.50
Length x Order Interaction	1	1122.61	1.44
Error	18	777.84	
Within Subjects			
Text Type	2	2697.64	6.62*
Type x Length Interaction	2	159.14	.39
Type x Order Interaction	2	96.27	.24
Type x Length and Order	2	16.77	.04
Error	36	407.32	

* $p < .005$

The resultant mean percentages are graphically displayed in Figures 16a and 16b. The graphs indicate that, in keeping with our predictions, stories were recalled better than definitions and instructions. Students also recalled more terminal nodes from instructions than from definitions. Contrary to our predictions, however, students recalled the propositional content of definitions better than that of instructions. In other words, the students recalled more semantic detail for definitions but included more structural content for instructions. In summary, then, students recalled a greater percentage of the content of short texts than of long texts. Further, stories were better recalled than were definitions or instructions.

As with the data on summaries, we investigated qualitative as well as quantitative differences in recall. To determine if some terminal nodes were recalled more often than other nodes, a repeated measures ANOVA was conducted for each passage to compare the percentage of students who recalled each node. The results of the ANOVA for each passage are summarized in Table 4. As with the summary data, terminal nodes are not necessarily recalled with equal frequency. Although the effect does not reach significance for all passages, the nodes tend to be recalled to different degrees for all passages. These apparent differences are evident in the graphic portrayal of terminal node recall presented in Figures 17, 18, and 19 for the short texts. Graphs of the percent of students recalling each terminal node for the longer texts are included in the Appendix in Figures 27, 34, and 38. Please notice that these graphs also contain results of the subsequent experiments and will, therefore, be discussed in a later section.

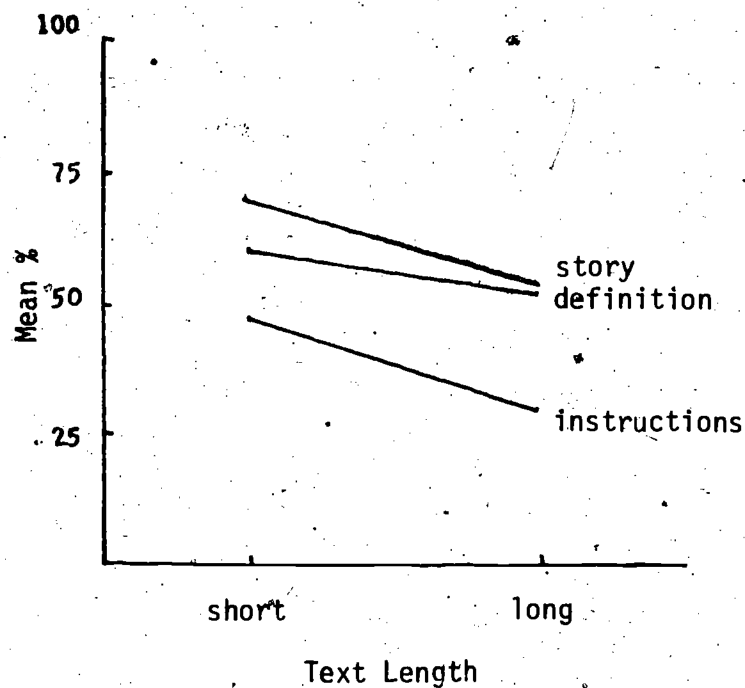

Fig. 16a: Mean Percent Propositions Recalled as a Function of Text-Type and Length

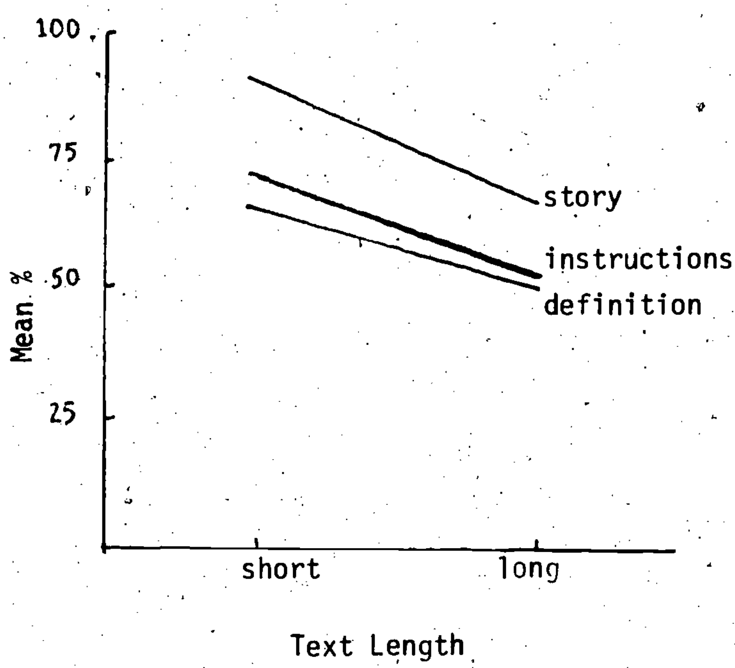

Fig. 16b: Mean Percent Terminal Nodes Recalled as a Function of Text-Type and Length

Table 4. Results of Repeated Measures ANOVAs for Inclusion of Terminal Nodes in Recalls

Text	Number Terminal Nodes	F
The Dog and His Shadow	9	2.18
Redistributing the Filler	8	4.15*
Immune System	11	4.62*
The Old Farmer	24	2.88*
Making a Concrete Planter	24	1.99
Nematodes	27	1.86

Note. $N = 22$ for each analysis

* $p < .005$.

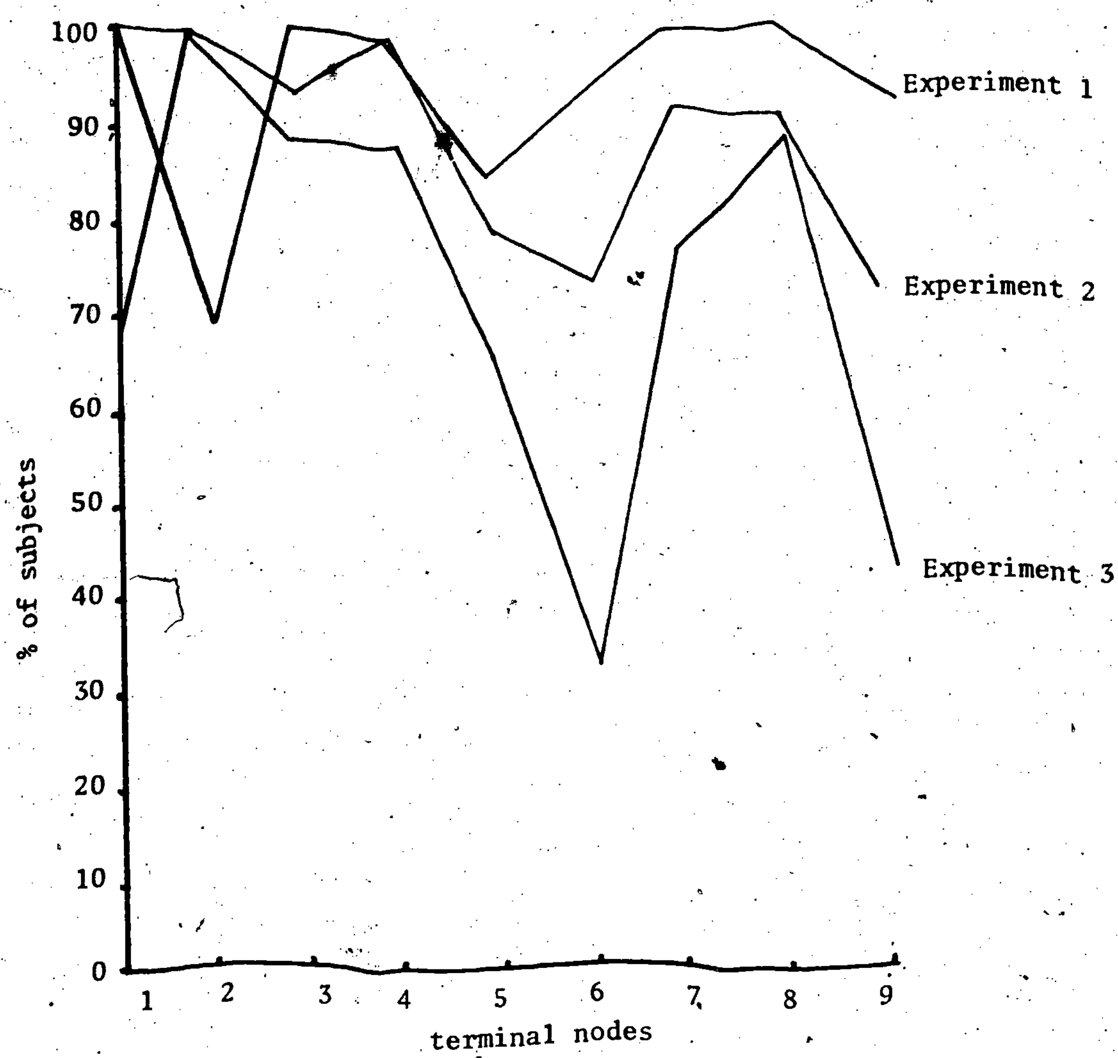

Figure 17. Percent of subjects recalling each terminal node of "The Dog and his Shadow" (Short Story).

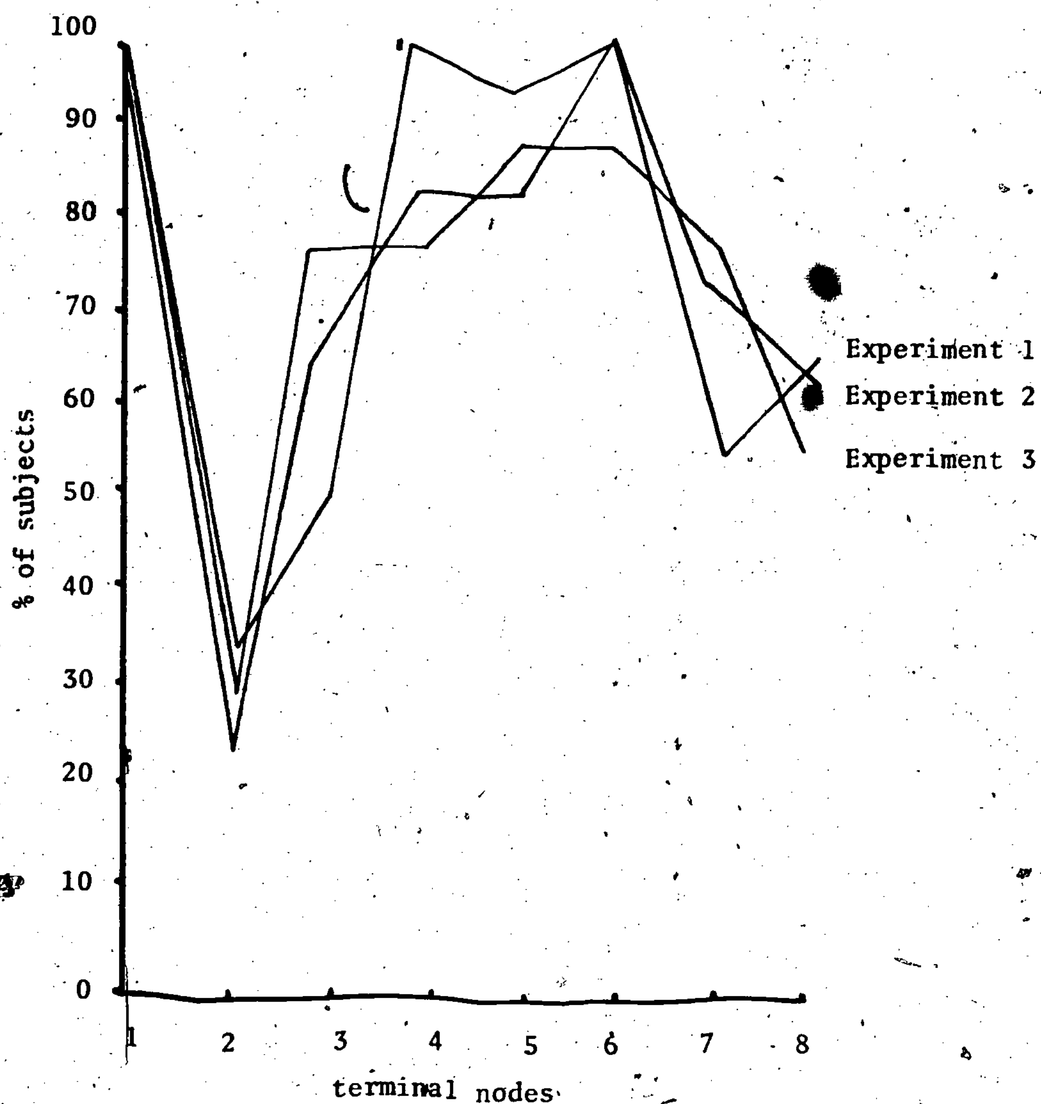

Figure 18. Percent of subjects recalling each terminal nodes of "Redistributing the Filler in a Sleeping Bag" (Short Introduction).

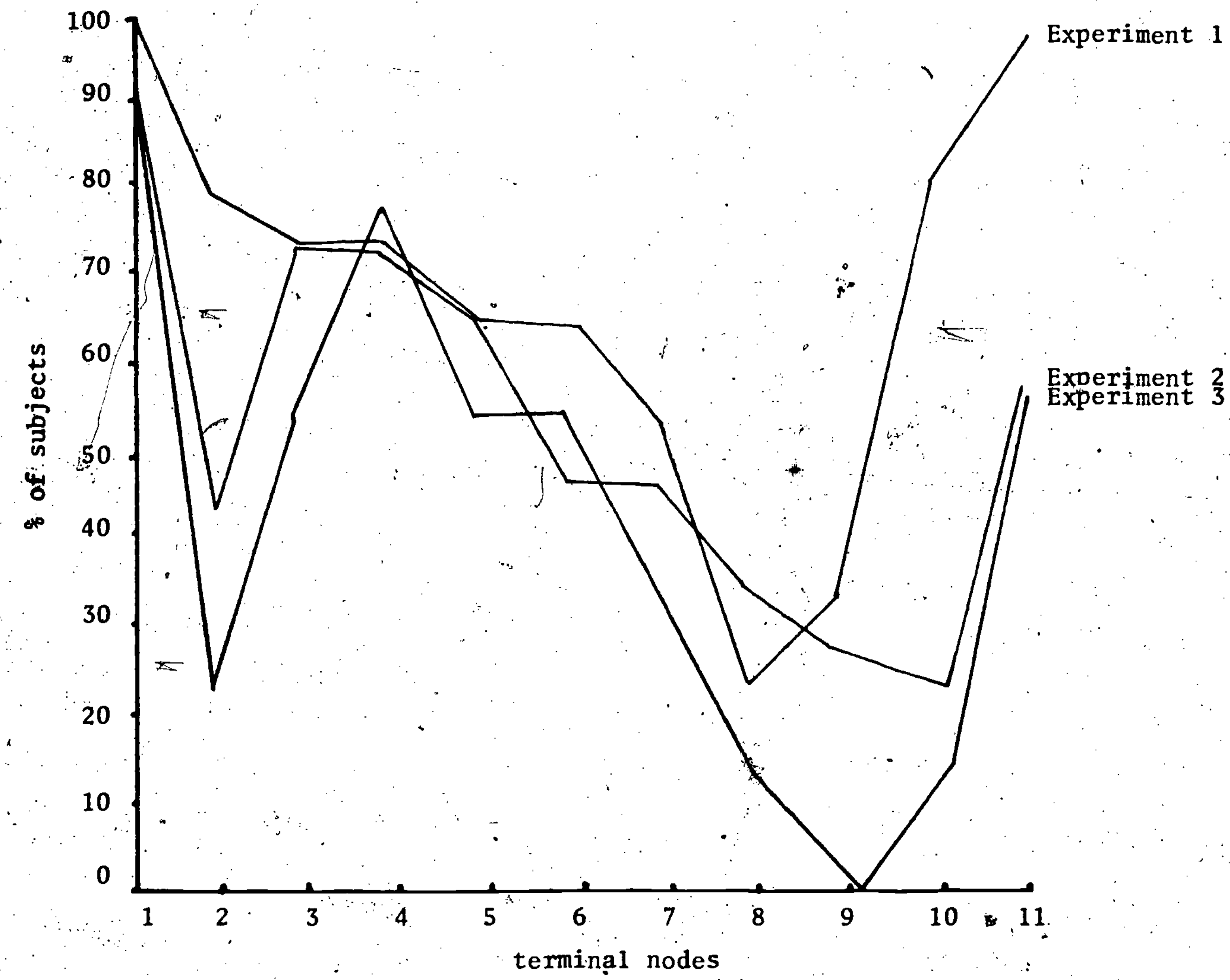

Figure 19. Percent of subjects recalling each terminal node of "Immune System" (Short Definition).

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Experiment 2

The results of experiment 1 included one aspect that was puzzling from the viewpoint of our theoretical orientation. We had predicted that stories would be recalled better than instructions and definitions and that instructions would be recalled better than definitions. In the data of experiment 1, stories were recalled better than the other two text-types, but the propositional content of definitions was recalled better than that of instructions. Students in experiment 1 not only read and recalled the text that were presented to them; they also summarized the texts before being asked to recall the texts. While summarizing they were given the opportunity to reread all or portions of the text they were summarizing. This rereading and summarizing can be thought of as the application of a reading strategy or study habit. We hypothesized that the use of this strategy may have a differentially facilitative effect on later recall, benefiting the recall of definitions more than that of instructions. We believed that when there was a single-pass exposure to all the texts, recall of the instructions would be superior to that for definitions (with respect to both terminal nodes and propositions).

In order to test this hypothesis, experiments 2 and 3 were conducted. Students were exposed to a single-pass presentation by using tape recorded texts rather than written texts. Experiments 2 and 3 were also conducted with a second purpose. We expected that the information recapitulated in recalls would not necessarily be in the same linear order as in the original text. Judging by the structures, we expected that reordering of content would be easier in more horizontal and less predictable texts. Thus, we predicted that definitions would show the most reordering and stories the least.

Other types of data were collected from subjects in addition to the recalls. Students were required to classify texts according to type. We expected that people would categorize stories as different from definitions and instructions, and instructions as different from definitions.

We also collected subjects' judgments of the difficulty of the text presented to them. In keeping with our predictions about recall, we expect readers to judge stories easier to recall and understand than other text types. Instructions would be next hardest and definitions would be the hardest. These factors would also be supported by other aspects of the text-types (for example, the nature of their semantic content and their pragmatic content).

Method

Twenty-three undergraduate college students chose to participate in this experiment for credit in an introductory psychology course. All students received the same treatment since this is a within-subjects design. The two factors are text type (story, definition, and instruction) and text length (long and short). The students were tested in groups of two to four. They were instructed that they would hear a number of passages and that they should listen carefully to remember the passages verbatim. Six texts were presented on tape. After each text, there was a one-minute intervening task. Then the students were aksed to write out everything they could recall as completely and exactly as they could. Only one order of presentation was used, since Experiment 1 had shown that there was no effect due to order. The stimulus texts were presented in this order:

"The Dog and His Shadow"

"Redistributing the Filler in a Sleeping Bag"

"Immune System"

"The Old Farmer and His Stubborn Donkey"

"Making a Concrete Planter"

"Nematodes"

On completing their recall task, twelve of the students were asked to answer a questionnaire. They were asked:

(1) to rank order the texts for difficulty in comprehension;

(2) to rank order the texts for difficulty of recall; and

(3) to group together similar texts.

Unlimited time was provided for both recall and for responding to the questionnaire.

Results

Again for both propositions and terminal nodes, we calculated the mean proportion of text recalled by the students. The means are graphically presented in Figures 20a and 20b. As we predicted, stories were recalled better than definitions. Instructions were sometimes recalled as well as stories and sometimes as poorly as definitions. This result is more in keeping with our predictions, unlike the results of Experiment 1.

In order to statistically test our predictions about recall of different types of texts, we ran a series of within-subject paired t-tests. These tests compared recall of different text types and recall of similar text types of different length. Again, due to the large number of tests, we adopted the stringent alpha level of .005.

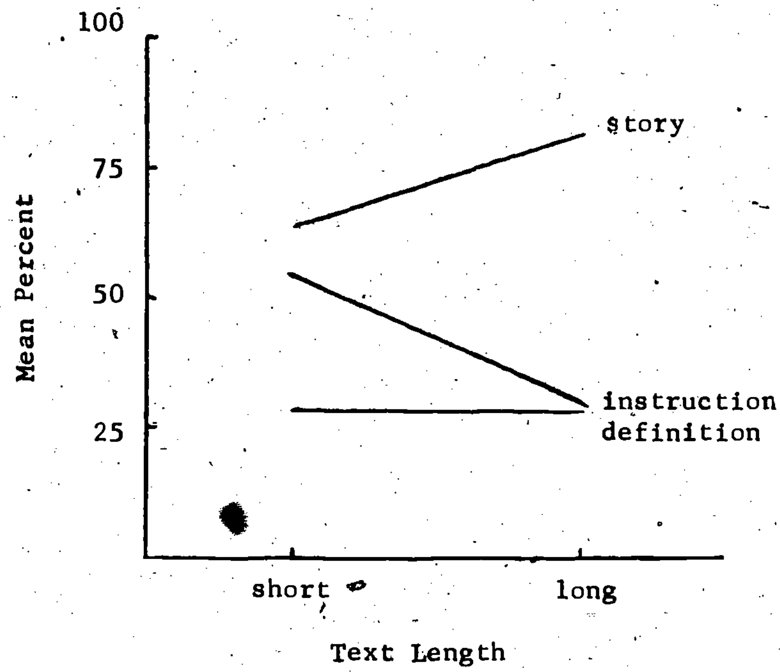

Figure 20a. Mean percent propositions recalled as a function of text type and length.

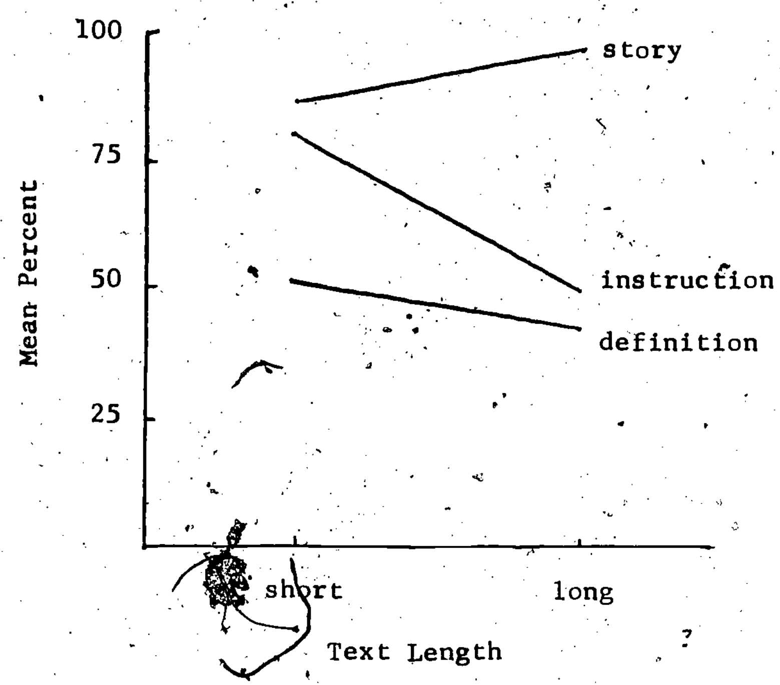

Figure 20b. Mean percent terminal nodes recalled as a function of text type and length.

Recall. Our first prediction is that, for texts of similar length, text type will affect recall. In particular, we predict that stories should be remembered better than instructions and definitions, and that instructions should be recalled better than definitions.

The results indicate that the short story differed from the short definition both in proportion of propositions recalled ($\underline{t}(22) = 7.78$, $\underline{p} < .005$) and on proportion of terminal nodes recalled ($\underline{t}(22) = .723$, $\underline{p} < .005$). The short instruction and definition also differed in terms of the proportion of propositions recalled ($\underline{T}(22) = 4.84$, $\underline{p} < .005$) and proportion of terminal nodes recalled ($\underline{t}(22) = 4.68$, $\underline{p} < .005$). The short story and the short instruction did not differ in terms or proportional amount of content recalled.

Among the long texts, the recalls of the story and the definition again differed in terms of both proportion of propositions recalled ($\underline{t}(22) = 18.76$, $\underline{p} < .005$) and proportion of terminal nodes recalled ($\underline{t}(22) = 13.57$, $\underline{p} < .005$). The story was also recalled differently than the instruction on the basis of proportion of propositions recalled ($\underline{t}(22) = 19.70$, $\underline{p} < .005$) and proportion of terminal nodes recalled ($\underline{t}(22) = 11.00$, $\underline{p} < .005$). The long definition was not recalled differently than the long instruction.

As in Experiment 1, the recall of terminal nodes was compared to determine if all nodes were recalled to the same degree. The percentage of students who recalled each terminal node of a text was compared via a repeated measures ANOVA for each passage. The results of the six analyses (one for each passage) are summarized in Table 5. The results indicate that terminal nodes differ in their likeliness to

Table 5. Results of Repeated Measures ANOVAs for Inclusion of Terminal Nodes in Recall

Text	Number of Terminal Nodes	F
The Dog and his Shadow	9	3.18*
Redistributing the Filler	8	10.96*
Immune System	11	5.32*
The Old Farmer	24	4.00*
Making a Concrete Planter	24	3.48*
Nematodes	27	5.88*

Note. N = 23 for each analysis.

* $p < .005$.

be recalled. Some nodes are very likely to be recalled while others are not. These results are graphically portrayed for the short texts in Figures 17, 18, and 19 and for the long text in Figures 27, 34, and 38 in the Appendix.

The second prediction is that texts of the same type will not be recalled differently. According to this prediction, texts of different lengths but of the same type should not have different proportions of recalled text.

Results indicate that long definitions were recalled as well as short definitions. Length did affect recall of stories, however. Longer stories were recalled to a greater degree than short stories on the basis of propositions ($\underline{t}(22) = 3.72$, $\underline{p} < .005$). However, length did not affect recall of terminal nodes for stories. Length also affected the recall of both propositions and terminal nodes for instructions. Students recalled proportionately more propositions from short instructions than from long ones ($\underline{t}(22) = 6.34$, $\underline{p} < .005$) and proportionately more terminal nodes from short instructions than from long ones ($\underline{t}(22) = 5.66$, $\underline{p} < .005$).

Reordering. We predict that definitions should permit more reordering than stories, with instructions somewhere between the two. First, we predict that more people should reorder definitions than stories. We counted as reordering any movement of a terminal node from its linear order, with one exception: we did not count as reordering the movement of terminal nodes which are syntactically embedded within other terminal nodes so that the embedded node immediately precedes or follows the node in which is it embedded. Therefore, for each long text there were sections where we accepted either of two possible orders:

"The Old Farmer and his Stubborn Donkey"	7-8 or 8-7
	10-11 or 11-10
"Making a Concrete Planter"	1-2 or 2-1
"Nematodes"	1-2 or 2-1

Using these rules, the percent of students who did any reordering was calculated and the means are presented in Table 6. A student was assigned the score of one if he or she had reordered the text during recall and the score of zero for no reordering (other than the allowable reordering listed above). The percentages of students who reordered were low, medium and high for stories, instructions and definitions respectively. We ran paired t-tests to compare these reordering scores and found that stories were reordered by fewer students than were definitions ($\underline{t}(20) = 9.22$, $\underline{p} < .005$) or instructions ($\underline{t}\ (20) = 4.38$, $\underline{p} < .005$). Definitions did not differ from instructions on the basis of reordering scores.

In addition to scoring the occurrence of reordering, we also calculated the mean <u>degree</u> of reordering for each text. The degree of reordering score was determined by first counting the number of times that the student recalled a terminal node out of sequence. This number was then divided by the total number of terminal nodes recalled. A conservative scoring rule was followed such that a point was added to the student's score each time a terminal node preceded a node that appeared after it in the original text. Omission of nodes did not affect the score as long as the recalled nodes were not out of sequence. The means of these scores are presented in Table 7. Comparison of the means indicates that the story was reordered less during recall than either the definition ($\underline{t}\ (20) = 5.47$, $p < .005$) or the instructions ($\underline{t}\ (20) = 4.29$,

Table 6. Percent Students Who Reordered

Terminal Nodes During Recall

	n		Text Type: Story	Instructions	Definition
Experiment 2	21	$\bar{X}$	9.5	66.7	90.1
		SD	(30.1)	(48.3)	(30.1)
Experiment 3	8	$\bar{X}$	0	62.5	75.0
		SD	(0)	(51.8)	(46.3)

Table 7. Mean Degree of Reordering of

Terminal Nodes During Recall

	n		Text Type: Story	Instructions	Definition
Experimen 2	21	$\bar{X}$	.004	.093	.177
		SD	(.013)	(.090)	(.142)
Experiment 3	8	$\bar{X}$	0	.080	.249
		SD	(0)	(.682)	(.219)

$p < .005$). The difference in the degree of reordering between the definition and the instructions was not significant.

Ranking. Twelve of the students were asked to rank the six texts according to their relative difficulty to recall and comprehend. A score of 1 to 6 was assigned to each passage according to how the student ordered it. Then the rank order scores were averaged for each passage. Figures 21a and 21b present the mean ratings graphically. The difficulty ratings reflect the same pattern as the actual recall data--that is, stories were rated as easiest, while definitions were rated as most difficult to recall. The ratings for comprehension also matched the pattern of data for recalling the texts. Notice the close correspondence between the recall data displayed in Figures 20a and 20b and the rating means shown in Figures 21a and 21b.

These students were also asked to group similar texts together. There were not other instructions; no categories or judging rules were suggested. Students' judgements matched out categories quite closely. The results were:

100% of the students classed the two stories together;

91.6% of the students classed the two instructions together; and

91.6% of the students classed the two definitions together.

Experiment 3

This experiment replicated Experiment 2, with replacements for two of the texts. "Borrowing a Horse" was used instead of "The Old Farmer and his Stubborn Donkey," and "Courtly Love" took the place of "Nematodes." These changes were made for a number of reasons. We felt that the story of the farmer and his donkey had an unusually redundant structure that may have elevated recall far above the typical

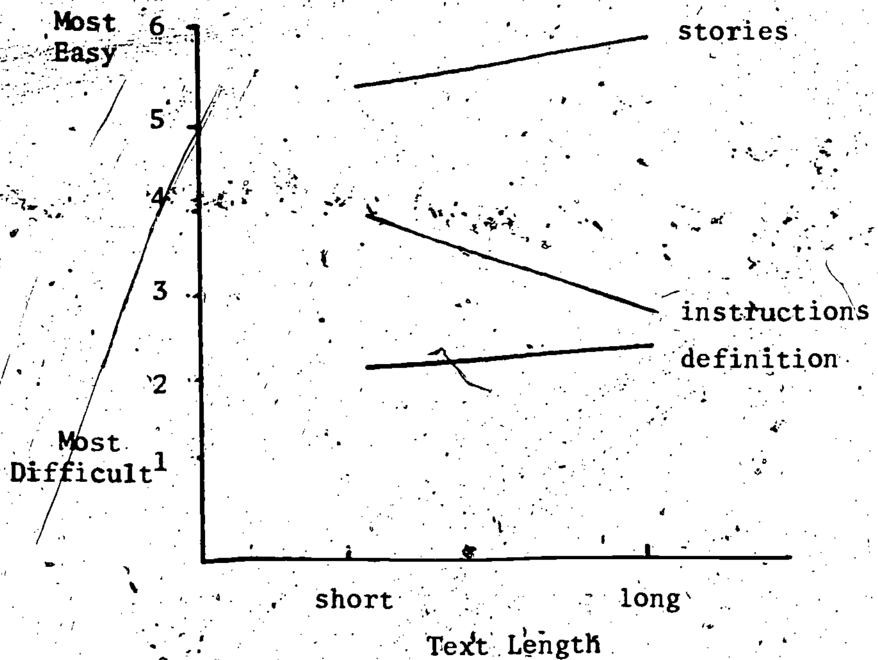

Figure 21a. Judged ease of understanding -- Experiment 2

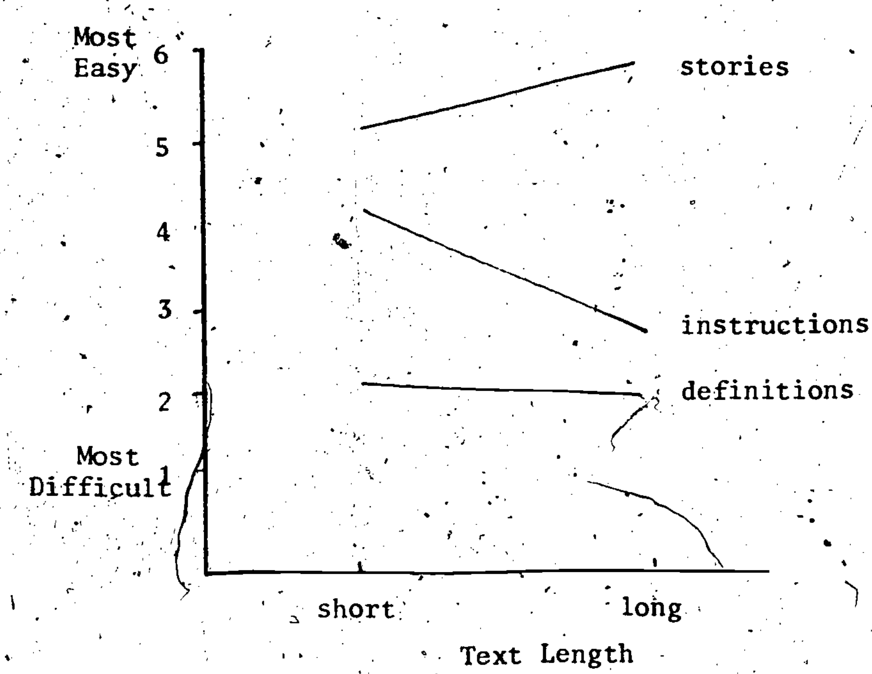

Figure 21b. Judged ease of recall -- Experiment 2

level for stories. It was replaced with a natural text found in a book of anecdotes in which the writing was obviously directed at adults (which may not be the case for the "Farmer" story). "Courtly Love" replaced the text on nematodes so that there would be only one text from the field of biology ("Immune System"). According to student reports, some students classified the two definitional texts together "Because they were both about biology" rather than on the basis of text type. "Courtly Love" was chosen as an example of a definitional explanation from a technical subject matter quite unrelated to the field of biology.

Method

Nine undergraduate college students chose to participate in this experiment for credit in an introductory psychology course. The procedure was similar to that in Experiment 1, except that students listened to the text passages on tape rather than read the texts in printed form. After hearing the texts, they performed a brief interfering task, and then wrote down what they could recall from the passages. Finally, students were asked to answer the questionnaire used in Experiment 2. Also like Experiment 2, this is a within-subjects design so that all students received the same treatment. The two factors are, again, text type and text length.

Results

Recall. The mean proportion of the propositions and terminal nodes recalled by the students for each text were calculated and are graphically presented in Figures 22a and 22b. These scores were

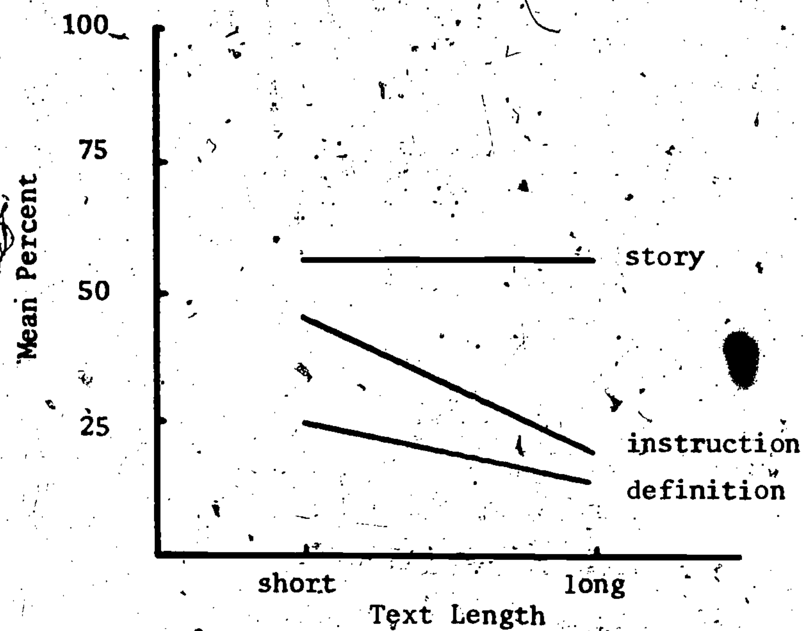

Figure 22a. Mean percent propositions recalled as a function of text type and length.

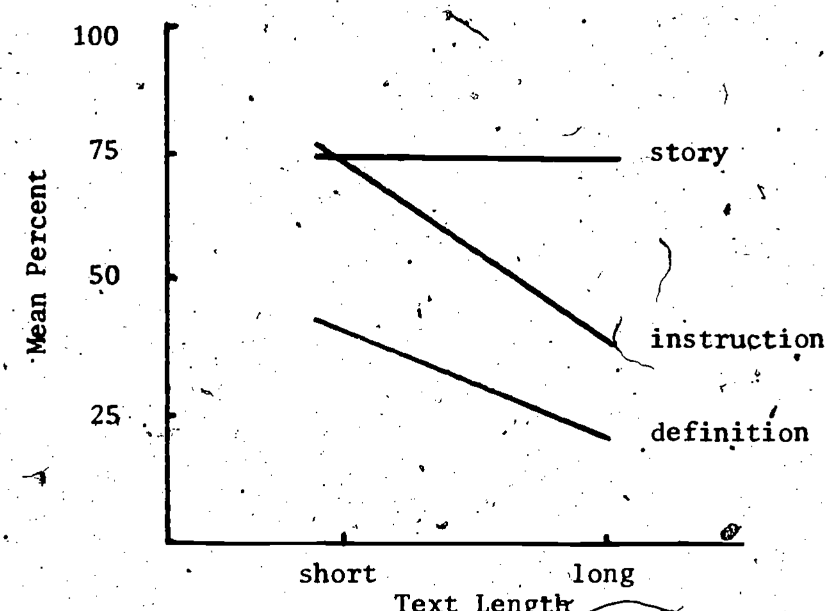

Figure 22b. Mean percent terminal nodes recalled as a function of text type and length.

compared and results are similar to those obtained in Experiment 2. As predicted, the short story was recalled better than the short definition in terms of the proportion of propositions recalled ($\underline{t}$ (8) = 3.93, $\underline{p} < .005$). Recall of terminal nodes followed the same pattern, but the difference was not significant ($\underline{t}$ (8) = 3.48, NS). The short story was not recalled differently than the short instruction. Students recalled more terminal nodes from the short instructions than from the short definition ($\underline{t}$ (8) = 5.89, $\underline{p} < .005$). They also tended to recall more propositions from instructions than from definitions, but the difference did not reach significance ($\underline{t}$ (8) = 3.66, NS).

Among the long texts, students recalled more material from stories than from instructions: terminal nodes ($\underline{t}$ (8) = 6.73, $\underline{p} < .005$) and propositions ($\underline{t}$ (8) = 5.75, $\underline{p} < .005$). Similarly, students recalled more from stories than from definitions, including proportionately more terminal nodes ($\underline{t}$ (8) = 17.06, $\underline{p} < .005$) as well as propositions ($\underline{t}$ (8) = 13.39, $\underline{p} < .005$). Finally, students recalled proportionately more terminal nodes from instructions than from definitions ($\underline{t}$ (8) = 3.98, $\underline{p} < .005$).

As predicted, recall of stories and definitions was not affected by text length. Long stories and long definitions were not recalled differently than short stories and short definitions, respectively. Length did affect recall of instructions, however. A larger proportion of terminal nodes was recalled from short instructions than from long instructions ($\underline{t}$ (8) = 7.22, $\underline{p} < .005$).

Reordering. The proportion of students who reordered the texts and the degree of reordering were calculated as before and the means are presented in Tables 6 and 7 along with the data of Experiment 2. The means of this experiment follow the same pattern as the previous results--namely, stories are not reordered during recall while instructions are reordered somewhat and definitions are reordered to a great extent. None of the pairwise comparisons differed significantly, however.

Ranking. Students ranked the texts according to difficulty level and then grouped the texts on the basis of category or type of text that each passage exemplified. The mean difficulty rating for each passage was calculated as in Experiment 2 and the ratings are presented graphically in Figures 23a and 23b. The rated ordering from easiest to most difficult for comprehension is: long story, short story, short instructions, short definition, long definition and long instructions. For difficulty of recall, they were ranked: long story, short story, short instructions, short definition, long instructions and long definition. The results of the text type classification are:

100% of the students classed the stories together;

100% of the students classed the instructions together; and

66.7% of the students classed the definitions together.

The results discussed thus far have all had to do with the total number of propositions or terminal nodes recalled for the different types of texts. We also make predictions about what will be recalled. As we have seen in the previous experiments, the terminal nodes of each text differ is their likelihood of being recalled. In this experiment, terminal nodes were differentially recalled in three of the six texts. Table 8 presents a summary of the analysis for each passage. In the short story, the short definition and the long story, the terminal nodes were differentially recalled. The proportion

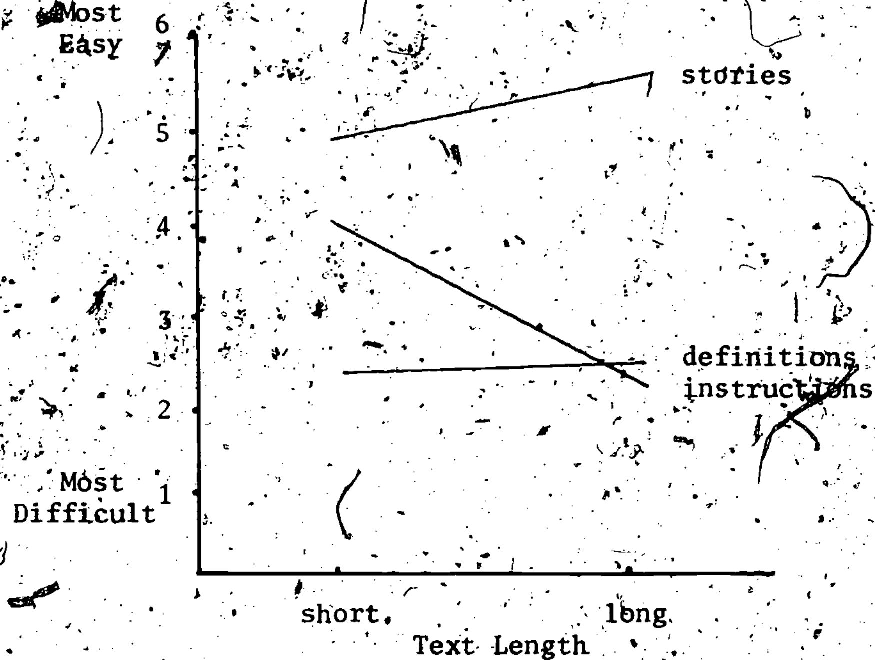

Figure 23a. Judged ease of understanding -- Experiment 3

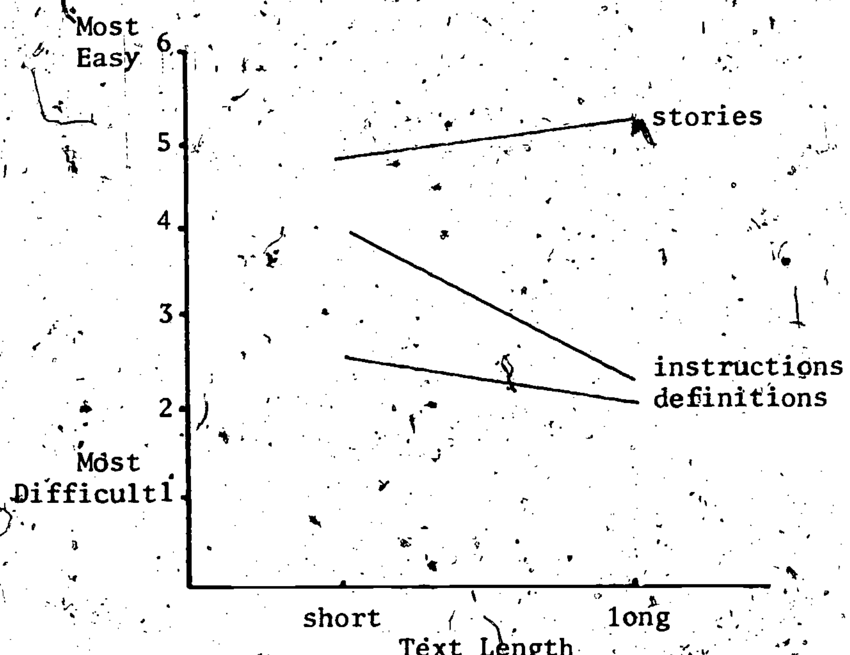

Figure 23b. Judged ease of recall -- Experiment 3

Table 8: Results of Repeated Measures ANOVAs for Inclusion of Terminal Nodes in Recall

Text	Number of Terminal Nodes	F
The Dog and His Shadow	9	4.17*
Redistributing the Filler	8	1.30
Immune System	11	3.15*
Borrowing a Horse	21	6.22*
Making a Concrete Planter	24	1.61
Courtly Love	26	1.77

Note. $N = 9$ for each analysis.

* $p < .005$.

of the students recalling the terminal nodes of each text can be found in Figures 17, 18 and 19 (in text) and in Figures 30, 34 and 41 (in Appendix). For the four texts which were included in all three experiments, the figures include the results of all three experiments--visual inspection permits note of the similarities in the pattern of recall of the texts by the students participating in the different experiments. In stories, the terminal nodes recalled depend upon the kind of terminal node and its role in the hierarchy, not merely position in linear order--first MOTIVEs and final OUTCOMEs (the first OUTCOME which resolves the main plot) are recalled in all three experiments. In the short instructions, the recalls from all three experiments are remarkably similar--the PRODUCT and the first CONDITION of the MAIN-SEQUENCE are recalled best. In the long instructions, the three experiments demonstrate less consistent results. The definitions reflect the greatest effect of linear order--the first TRAIT and the last TRAIT (to a somewhat lesser extent) are included in the recalls.

Conclusions

Texts clearly differ in both quantity of propositions recalled and which propositions are recalled. We believe that they differ in large degree due to difference in text-type, although that is undoubtedly not the only factor.

The text-type assignments given by us to the texts are clearly confirmed by the judgments of our subjects as to how the texts should be grouped. The recall data also strongly tended to confirm these assignments. Stories are easiest to recall and understand. Definitions are hardest to recall and understand. Instructions vary the most, with length apparently a more complicating factor with this type than with definitions or stories. The differences in recall are predictable from our analyses of the texts. More work needs to be done comparing texts of various types along other parameters than quantity of recall.

The texts of different types also differed significantly in the amount of reordering of the structural elements in recall. Stories, which are highly structured, were reordered very little. The less structured instructions and definitions, however, suffered significantly more reordering in recalls.

A particularly intriguing result was found in the relative memorableness of the same definitions and instructions under the different conditions of Experiment 1 and 2. When subjects were allowed to reread and summarize texts (in Experiment 1), they recalled more of the propositional content of definitions than of instructions. In Experiment 2, when subjects had only one exposure to each text, in the form of a tape recording, then instructions were recalled better than definitions. These results suggest that certain learning strategies (such as rereading and summarizing) may have differentially beneficial effects for different types of texts.

Our theory and the text analyses we have proposed require more testing. In particular, the specific text structure proposed for each text needs to be more thoroughly tested. It is necessary to discover whether text structure has effects separate from the semantic relations that are encoded in it. Future work should also include an examination of the effects of lexical semantic complexity on perception of text-types and on recall and comprehension of different types of texts.

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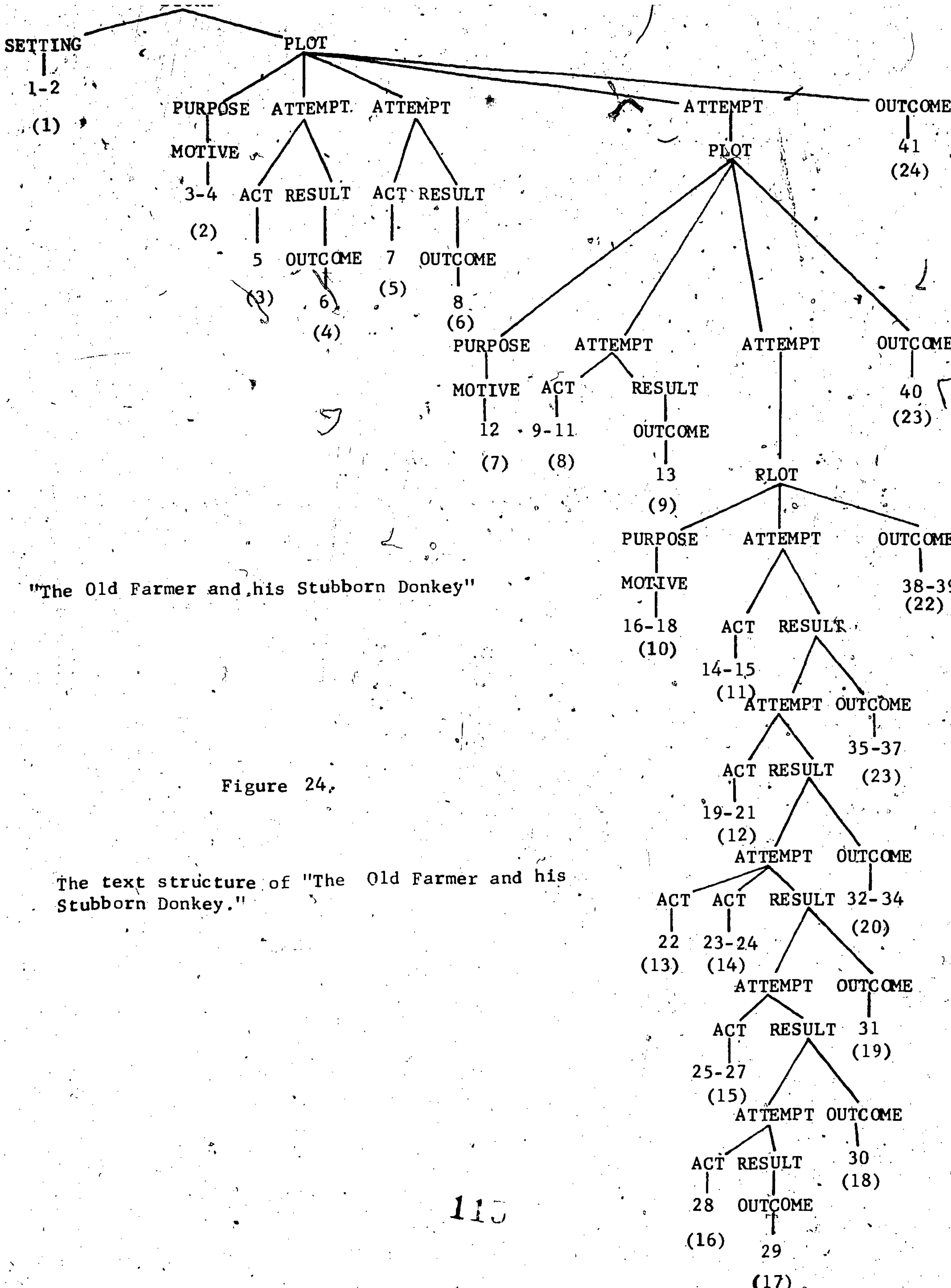
APPENDIX

Contents

The Old Farmer and his Stubborn Donkey (story)

1. There was once an old farmer
2. who owned a very stubborn donkey.
3. One evening the farmer wanted
4. to put his donkey in its shed.
5. First, the farmer pulled the donkey,
6. but the donkey wouldn't move.
7. Then the farmer pushed the donkey,
8. but still the donkey wouldn't move.
9. Finally, the farmer asked his dog
10. to bark...(11)...at the donkey
11. loudly
12. and thereby frighten him into the shed.
13. But the dog refused.
14. So then, the farmer asked the cat
15. to scratch the dog
16. so the dog would bark
17. loudly
18. and thereby frighten the donkey into the shed.
19. But the cat replied
20. "I would gladly scratch the dog
21. if only you would give me some milk."
22. So the farmer went to his cow
23. and asked for some milk
24. to give to the cat.
25. But the cow replied,
26. "I would gladly give you some milk
27. if only you would give me some hay."
28. Thus, the farmer went to the haystack
29. and got some hay.
30. As soon as he gave the hay to the cow,
31. the cow gave the farmer some milk.
32. Then the farmer went to the cat
33. and gave the milk to the cat.
34. As soon as the cat got the milk,
35. it began
36. to scratch the dog.
37. As soon as the cat scratched the dog,
38. the dog began
39. to bark.
40. The barking so frightened the donkey
41. that it jumped immediately into its shed.



"The Old Farmer and his Stubborn Donkey"

Figure 24.

The text structure of "The Old Farmer and his Stubborn Donkey."

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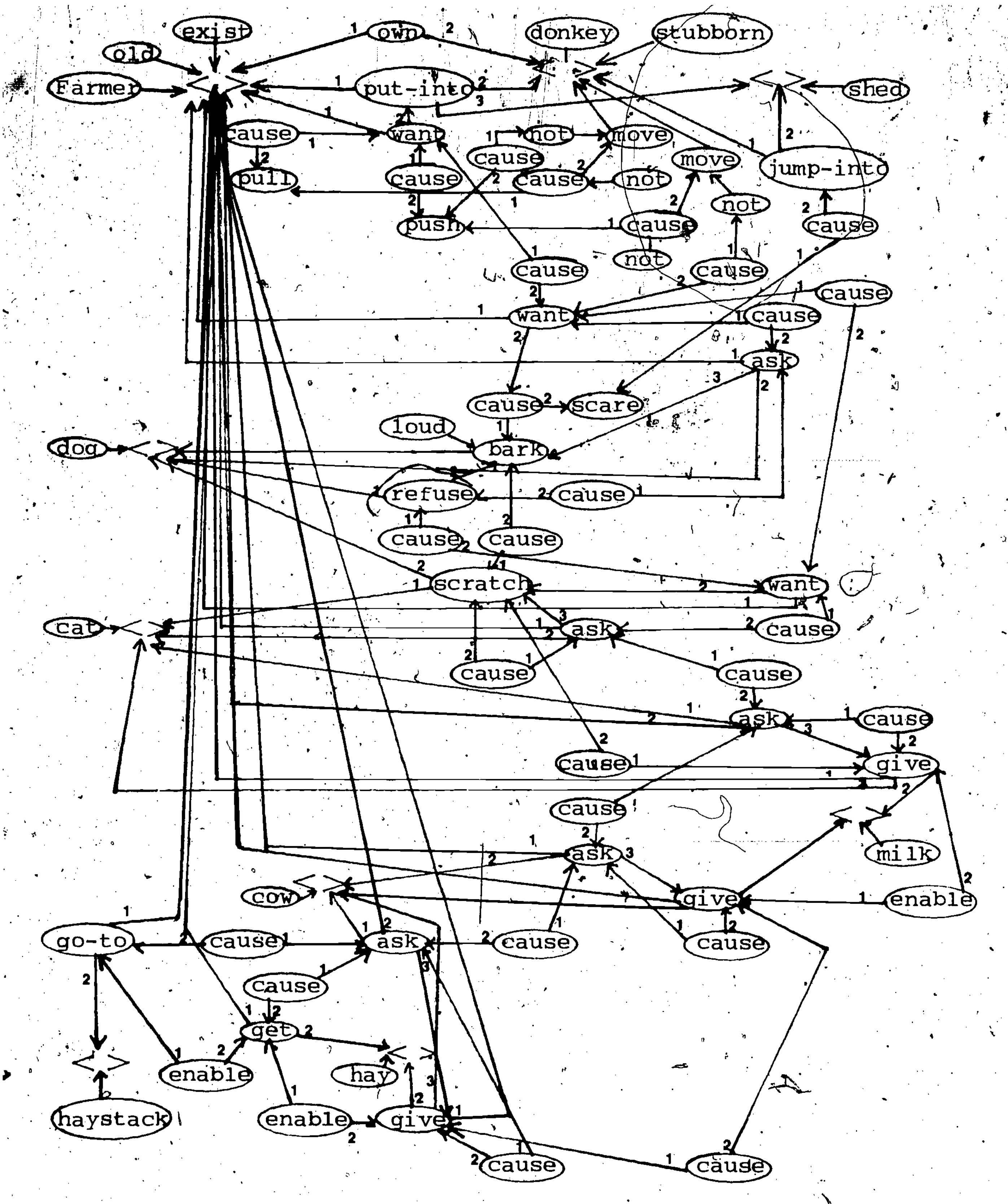

Figure 25. Semantic Representation of "The Old Farmer and his Stubborn Donkey"

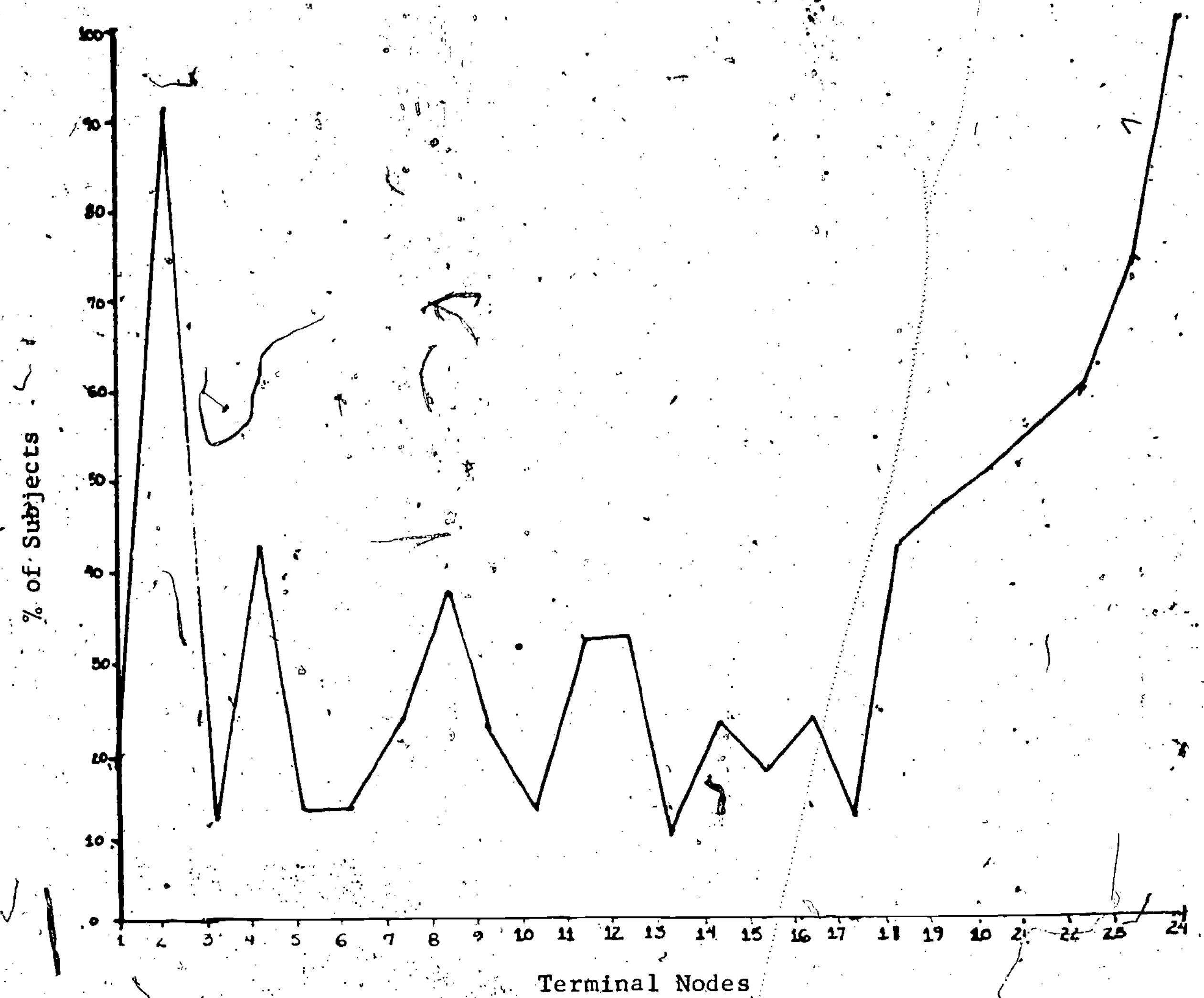

Figure 26. % of subjects who include each terminal node in summary of "The Old Farmer and his Stubborn Donkey."

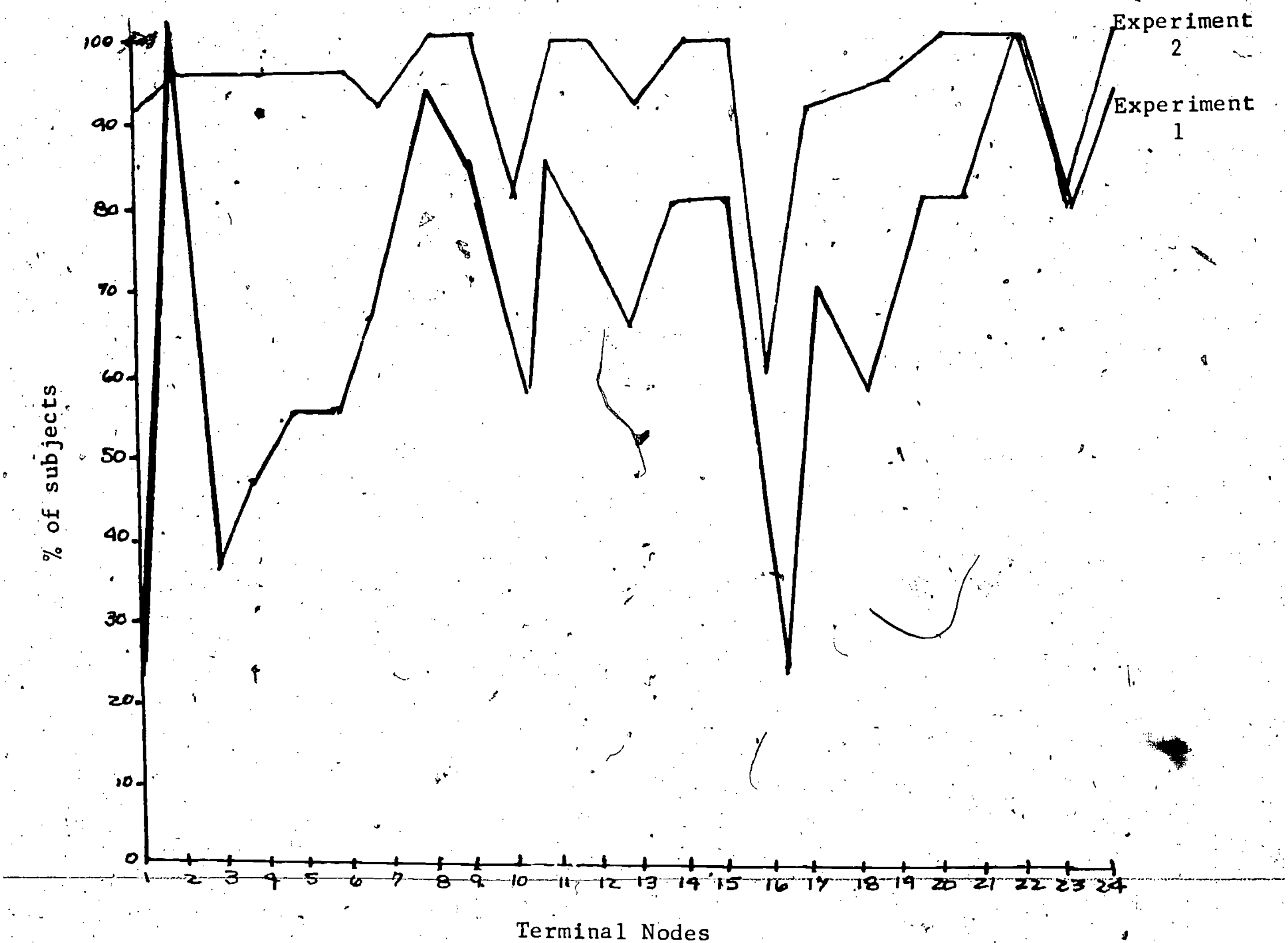

Figure 27. % of subjects recalling each terminal node of "The Old Farmer and His Stubborn Donkey."

Text A-2

<u>Borrowing a Horse (story)</u>

1. A Yankee,...(2)..., saw two horses in a field
2. walking through the country
3. as he passed along.
4. He decided
5. to borrow one for a few miles
6. as he was very tired.
7. So he wrote on a piece of paper
8. that he would leave the horse at the next town
9. on the road
10. and tied the note to one horse's leg
11. and rode away on the other horse.
12. This activity was reported to the owner of the animals.
13. He saddled the remaining horse
14. without noticing the note
15. attached to its leg
16. and rode after the unknown borrower.
17. Unluckily for the Yankee, he had taken the slower of the two horses.
18. He soon noticed
19. with some consternation,...(19)..., a rider
20. behind him
21. evidently chasing him.
22. The Yankee couldn't force
23. his horse to run faster,
24. so his pursuer had every chance of
25. catching him immediately.
26. Then he saw a cottage
27. by the roadside just ahead,
28. and so he headed toward it,
29. with the farmer still in hot pursuit.
30. Reaching the door,
31. he dismounted
32. and ran in.
33. The farmer,...(33)..., threw himself off his horse
34. riding up immediately after him in a rage
35. leaving it beside the other horse.
36. He ran into the cottage
37. to catch the thief,
38. but the Yankee was ready for him.
39. He had slipped upstairs
40. and opened the front window,
41. which overlooked the road.
42. As the farmer ran into the house,
43. the Yankee let himself down outside,
44. mounted the saddled horse,
45. grabbed the other by the halter
46. and rode off
47. safely
48. with both horses.

"Borrowing A Horse"

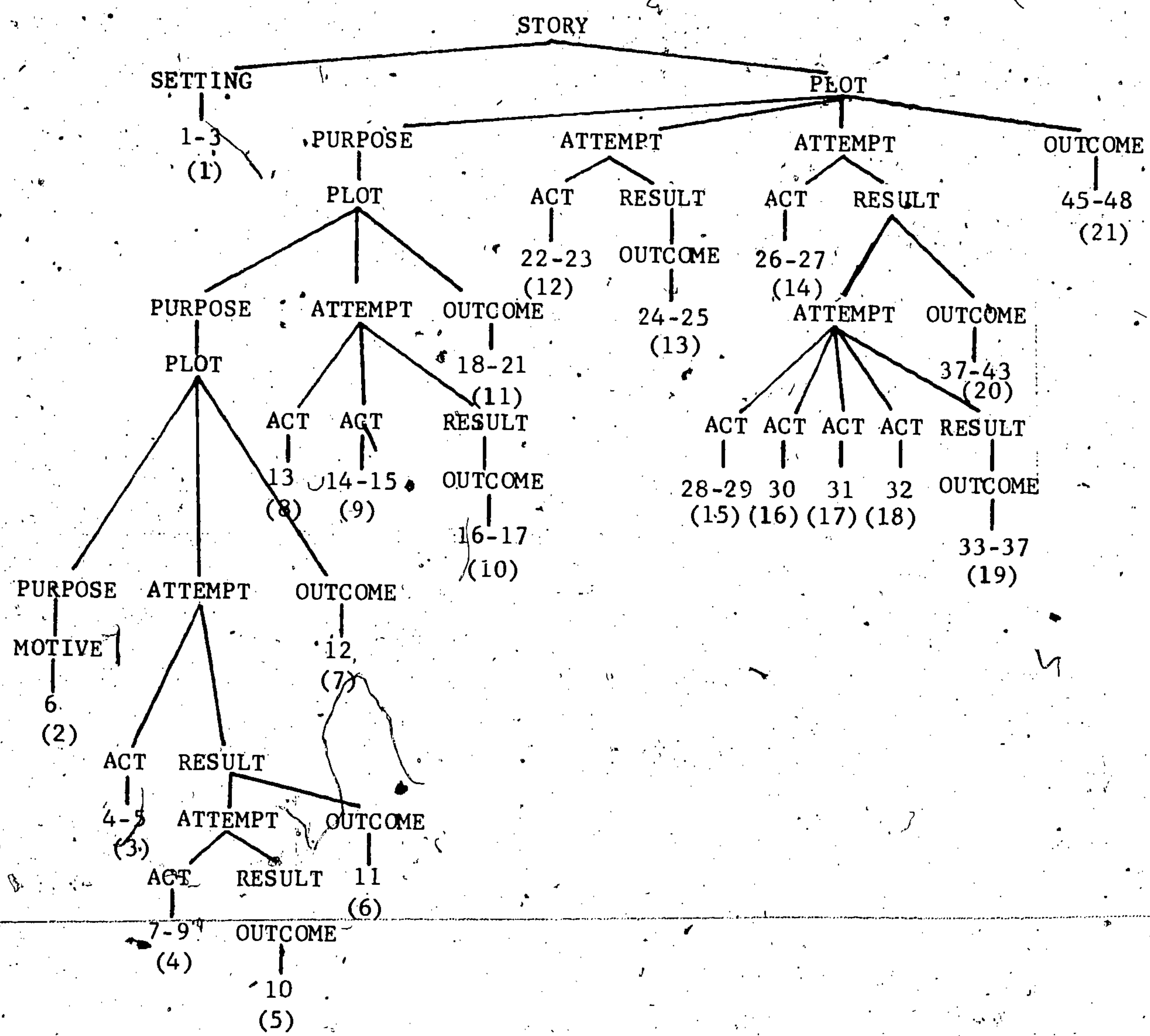

Figure 28.

The text structure of "Borrowing a Horse."

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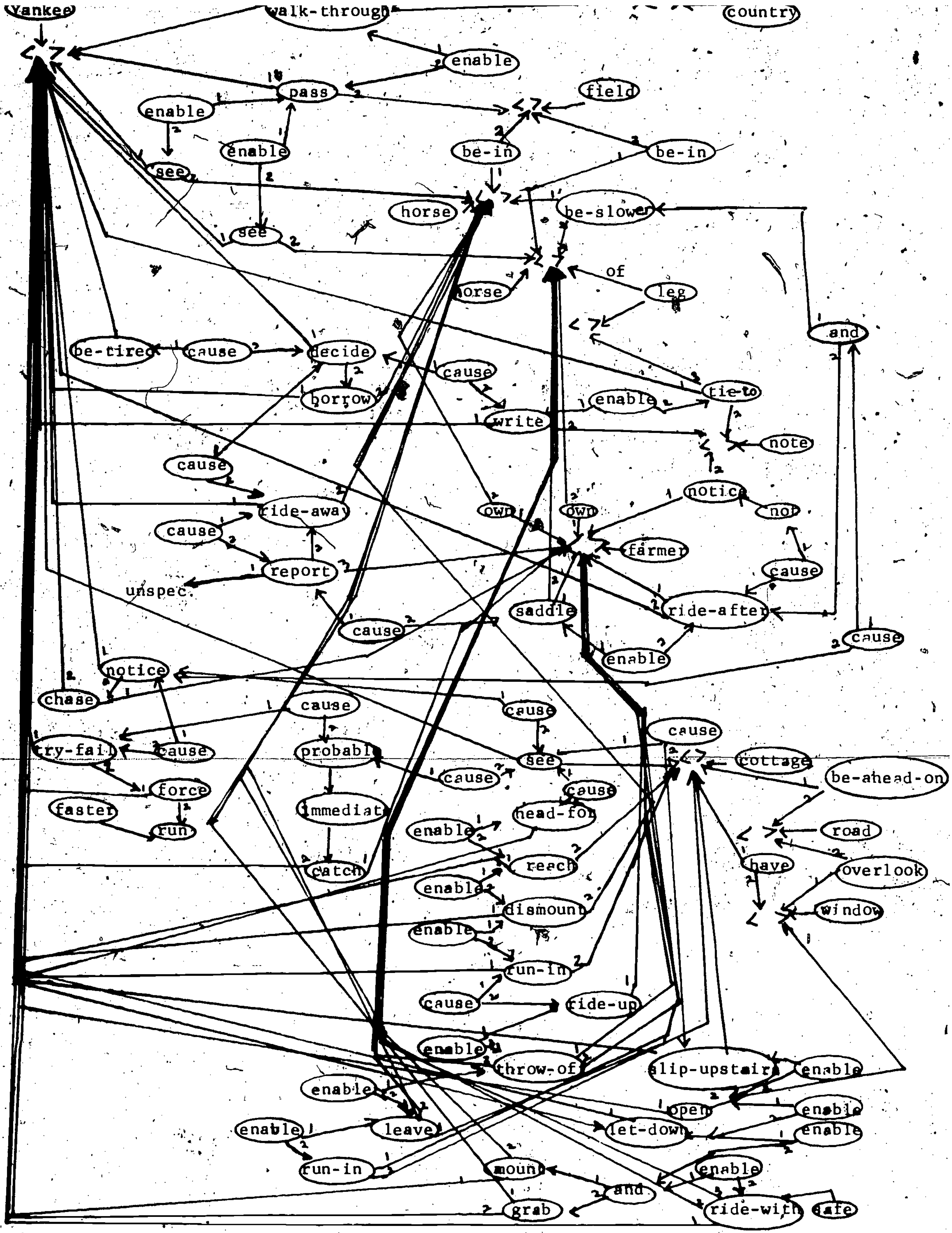

Figure 29. Semantic Representation of "Borrowing a Horse"

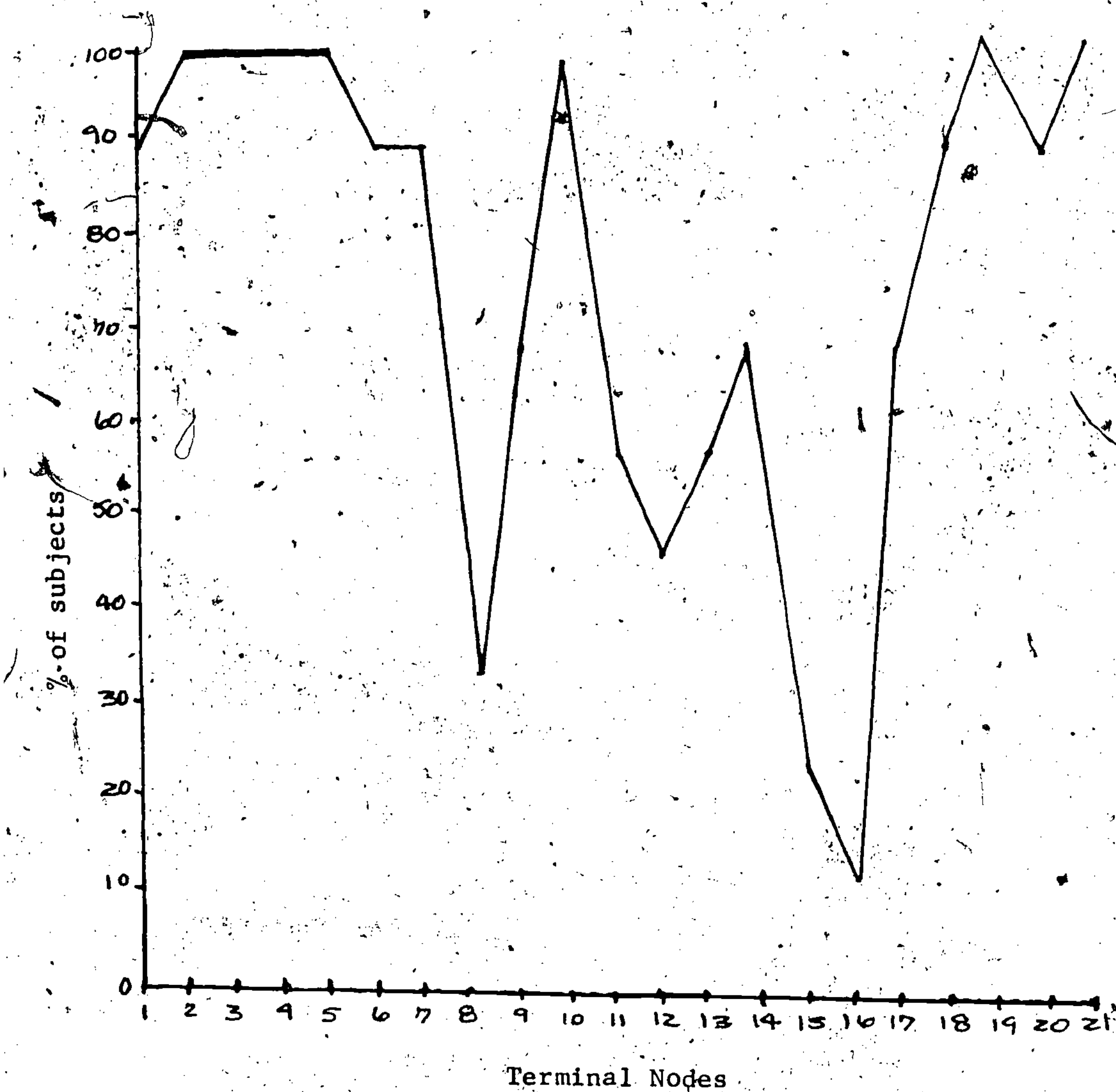

Figure 30. % of subjects recalling each terminal node of "Borrowing a Horse."

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<u>Making a Concrete Planter (instructions)</u>

1. Shallow garden containers...(3,4)...are scrace
2. and rearely inexpensive,
3. that are both good-looking
4. and sturdy.
5. A handsome concrete dish was made at home by Wm Snyder of Moscow, IN.
6. You make the dish with concrete mix
7. and a cardboard box
8. as a form.
10. not corrugated
11. too stiff a box won't sag
12. attractively
13. when you pour in the concrete.
14. A shallow box
15. or one..(16)...is easiest
16. cut down to 8 or 9 inches
17. to work in.
18. The amount of concrete...(19)...depends on the size of the container...(20)...
19. needed
20. you want.
21. A standard 60-pound bag will make two dishes
22. 12 by 12 square and about 4 inches tall.
23. Add enough water
24. to make a stiff mix;
25. then fill the box with it.
26. When you pour in the mix,
27. the box will dampen
28. and sag.
29. Use a wet trowel,
30. a large kitchen spoon
31. or even your hand
32. to make a depression
33. for plant roots;
34. gently
35. push down
36. and out from the center of the concrete,
37. filling in the corners
38. and up the sides of the box.
39. Push a piece of dowel
40. or broomstick through the bottom center of the damp dish;
41. remove it
42. just before the concrete hardens
43. to leave a drain hole.
44. While the concrete is still damp
45. but firmly set--
46. overnight drying should be enough--
47. strip away the cardboard box.
48. Use a coarse old file
49. to smooth down any rough
50. or sharp edges.
51. The container is excellent for plants
52. that grow in sparse amount of soil
53. and need little water.

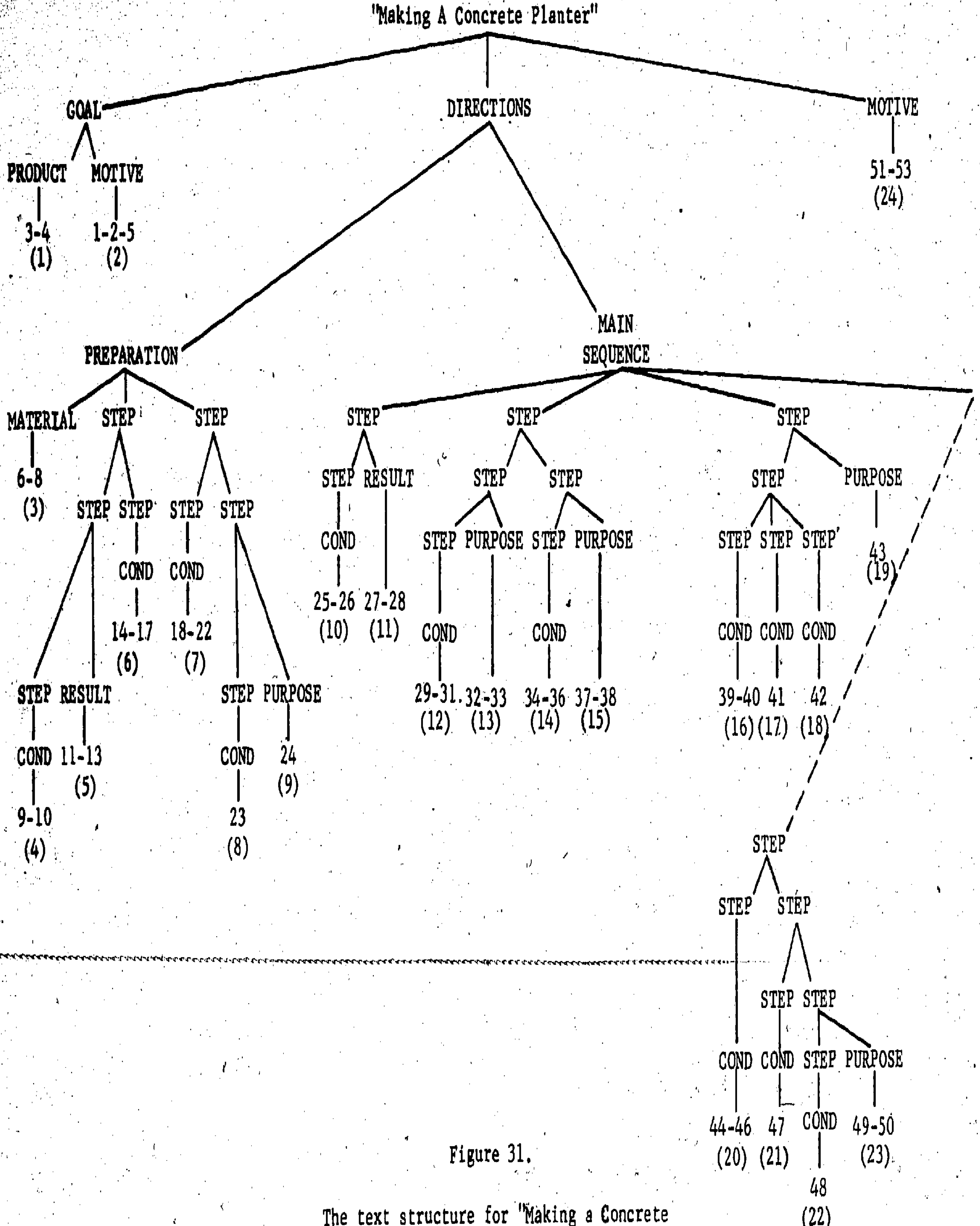

Figure 31.

The text structure for "Making a Concrete Planter."

Note: COND = CONDITION.

```
SHALLOW-GARDEN-CONTAINER (x)
        is when
GOOD-LOOKING (x)
STURDY (x)
SCARCE (x)
RARE (INEXPENSIVE (x))
MADE (WM.-SNYDER (OF (WM.-SNYDER, MOSCOW-IN)), KIND (x), at HOME (WM.-SNYDER))
USE (ACTOR. AND (CONCRETE-MIX, CARDBOARD-BOX (AS (CARDBOARD-BOX, FORM))), to
    PLANTER-CONSTRUCT (ACTOR, KIND (x)))
EXCELLENT-FOR (KIND (x), PLANTS (AND (GROW-IN (PLANTS, SPARSE-SOIL),
    NEED (PLANTS, LITTLE-WATER))))


PLANTER-CONSTRUCT (ACTOR, KIND (SHALLOW-GARDEN-CONTAINER))
        is when
PREPARE-FORM (ACTOR, CARDBOARD-BOX)
PREPARE-MIX (ACTOR, CONCRETE-MIX)
ENABLE (AND (PREPARE-FORM (ACTOR, CARDBOARD-BOX), PREPARE-MIX (ACTOR, CONCRETE-
    MIX)), POUR-INTO (ACTOR, CONCRETE-MIX, CARDBOARD-BOX))
POUR-INTO (ACTOR, CONCRETE-MIX, CARDBOARD-BOX)
CAUSE (POUR-INTO (ACTOR, CONCRETE-MIX, CARDBOARD-BOX), AND (DAMPEN (CARDBOARD-
    BOX), SAG (CARDBOARD-BOX)))
ENABLE (POUR-INTO (ACTOR, CONCRETE-MIX, CARDBOARD-BOX), MAKE-ROOT-SPACE
    (ACTOR, for PLANT))
MAKE-ROOT-SPACE (ACTOR, for PLANT)
AFTER (MAKE-ROOT-SPACE (ACTOR, for PLANT), FILL-IN (ACTOR, AND (CORNERS
    (CARDBOARD-BOX), SIDES (CARDBOARD-BOX)))
MAKE-DRAINHOLE (ACTOR)
WHILE (MAKE-DRAINHOLE (ACTOR), ALLOW (ACTOR, DAMP-SET (CONCRETE-MIX)))
STRIP-OFF (ACTOR, CARDBOARD-BOX, from CONCRETE-MIX)
ENABLE (STRIP-OFF (ACTOR, CARDBOARD-BOX, from CONCRETE-MIX), SMOOTH-DOWN
    (ACTOR, AND (ROUGH-EDGES (CONCRETE-MIX), SHARP-EDGES (CONCRETE-MIX))))
SMOOTH-DOWN (ACTOR, AND (ROUGH-EDGES (CONCRETE-MIX, SHARP-EDGES (CONCRETE-MIX))))
```

Figure 32 (part 1). The semantic representation of "Making a Concrete Planter"

```
PREPARE-FORM (ACTOR, CARDBOARD-BOX)
          is when
GET (ACTOR, CARDBOARD-BOX)
SINGLE-LAYER (CARDBOARD-BOX)
NOT (CORRUGATED (CARDBOARD-BOX))
IF (STIFF (CARDBOARD-BOX), then
    WHEN (POUR-INTO (ACTOR, CONCRETE-MIX, CARDBOARD-BOX), NOT (ATTRACTIVE
         (SAG (CARDBOARD-BOX)))))
MOST (EASY (WORK-IN (ACTOR, OR (SHALLOW (CARDBOARD-BOX), CARDBOARD-BOX
    (CUT-DOWN-TO (ACTOR, CARDBOARD-BOX, 8-9")))))
```

```
PREPARE-MIX (ACTOR, CONCRETE-MIX)
          is when
DEPEND (AMOUNT (CONCRETE), on SIZE (SHALLOW-GARDEN-CONTAINER))
ENOUGH (60-POUND-BAG(CONCRETE), MAKE (ACTOR, QUANTITY (SHALLOW-GARDEN-
    CONTAINER (SIZE (SHALLOW-GARDEN-CONTAINER, 12"x12"x4")), TWO)))
PREPARE-STIFF-MIX (ACTOR, CONCRETE)
```

```
PREPARE-STIFF-MIX (ACTOR, CONCRETE)
          is when
ADD-TO (ACTOR, WATER (ENOUGH (WATER, STIFF (CONCRETE-MIX))), to CONCRETE)
```

```
MAKE-ROOT-SPACE (ACTOR, for PLANT)
          is when
USE (ACTOR, OR (LARGE-KITCHEN-SPOON, WET-TROWEL, HAND), to MAKE (ACTOR,
    DEPRESSION (SIZE (DEPRESSION, ROOT-SPACE (PLANT)))))
```

Figure 32 (part 2). The semantic representation of "Making a Concrete Planter"

```
FILL-IN (ACTOR, AND (CORNERS (CARDBOARD-BOX), SIDES (CARDBOARD-BOX)))
        is when
GENTLE (PUSH (ACTOR, CONCRETE-MIX, DOWN-AND-OUT-FROM (CENTER (CONCRETE-MIX))))
ENABLE ( GENTLE (PUSH...), FILL (ACTOR, AND(CORNERS (CARDBOARD-BOX), SIDES
    (CARDBOARD-BOX)), with CONCRETE-MIX))
FILL (ACTOR, AND (CORNERS (CARDBOARD-BOX), SIDES (CARDBOARD-BOX)), with
    CONCRETE-MIX)


MAKE-DRAINHOLE (ACTOR)
        is when
PUSH (ACTOR, OR (DOWEL, BROOMSTICK), through CENTER (CONCRETE-MIX))
ENABLE (PUSH (ACTOR, OR (DOWEL, BROOMSTICK), through CENTER (CONCRETE-MIX)),
    REMOVE (ACTOR, OR (DOWEL, BROOMSTICK), from CENTER (CONCRETE-MIX)))
BEFORE (HARDEN (CONCRETE), REMOVE (ACTOR, OR (DOWEL, BROOMSTICK), from
    CENTER (CONCRETE-MIX)))


ALLOW (ACTOR, DAMP-SET (CONCRETE-MIX))
        is when
STILL-DAMP (CONCRETE-MIX)
FIRM (SET (CONCRETE-MIX))
CAUSE (OVERNIGHT (DRY (CONCRETE-MIX)), AND (STILL-DAMP (CONCRETE-MIX),
    FIRM (SET (CONCRETE-MIX))))


SMOOTH-DOWN (ACTOR, OR (ROUGH-EDGES (CONCRETE-MIX), SHARP-EDGES (CONCRETE-MIX)))
        is when
USE (ACTOR, FILE (AND (COARSE (FILE), OLD (FILE))), on OR (ROUGH-EDGES
    (CONCRETE-MIX), SHARP-EDGES (CONCRETE-MIX)))
```

Figure 32 (part 3). The semantic representation of "Making a Concrete Planter"

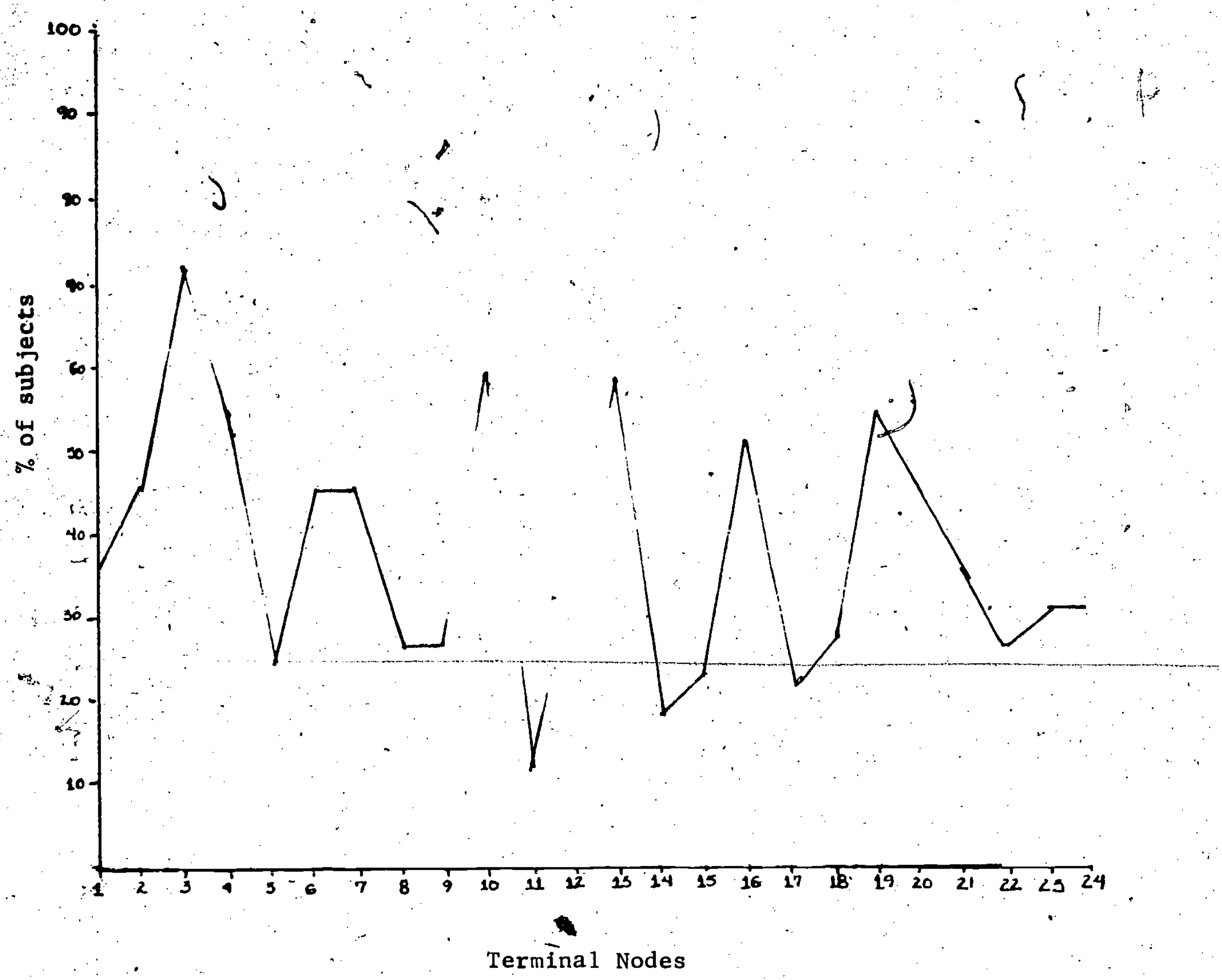

Figure 33. % of subjects who include each terminal node in summary of "Making a Concrete Planter."

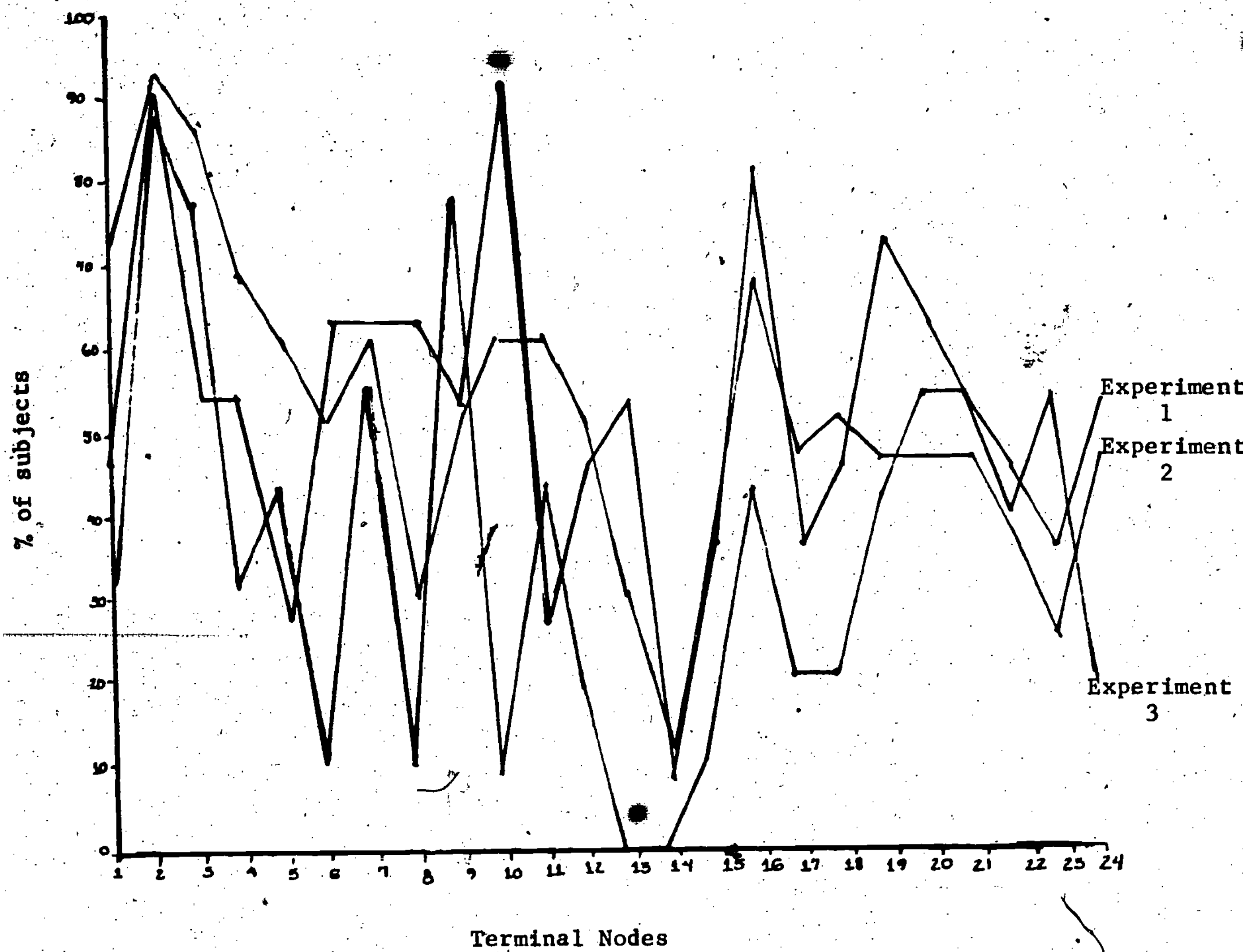

Figure 34. % of subjects recalling each terminal node of "Making a Concrete Planter."

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Nematodes (definition)

1. Nematodes...(2,3)...are tiny
2. that are parasitic on plants
3. (the only kind
4. that concern us here)
5. transluscent
6. roundworms
7. seldom longer than 1/16 of an inch,
8. and generally thread-like in form.
9. Nearly 2,000 species infest plant roots,
10. and at least 200 more types infest above-ground plant parts.
11. They exist in nearly all climates
12. and in all gardens,
13. but are not serious pests everywhere.
14. They're often problems on old agricultural land
15. that has been converted to housing;
16. they increase faster
17. and cause more damage in warmer climates
18. and in warmer seasons;
19. and they move about through sandy soils
20. more freely than through heavy clays.
21. Root-infesting nematodes are the most common
22. and widespread plant damaging kinds.
23. They either enter the root
24. and feed
25. while entirely housed there
26. (the endoparasites)
27. or remain outside the root in the soil
28. and feed at the plant surface
29. (the ectoparasites).
30. Both kinds suck out cell contents
31. through a stylet,
32. a kind of hollow spear
33. extended during feeding.
34. The result is a damaged root system.
35. The only symptoms...(34)...are slight leaf discoloration,
36. you can see...
37. without digging up the plant
38. weak
39. or reduced growth
40. poor production of flowers
41. or fruit,
42. and wilting on hot days
43. (often without subsequent recovery during the night).

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"Nematodes"

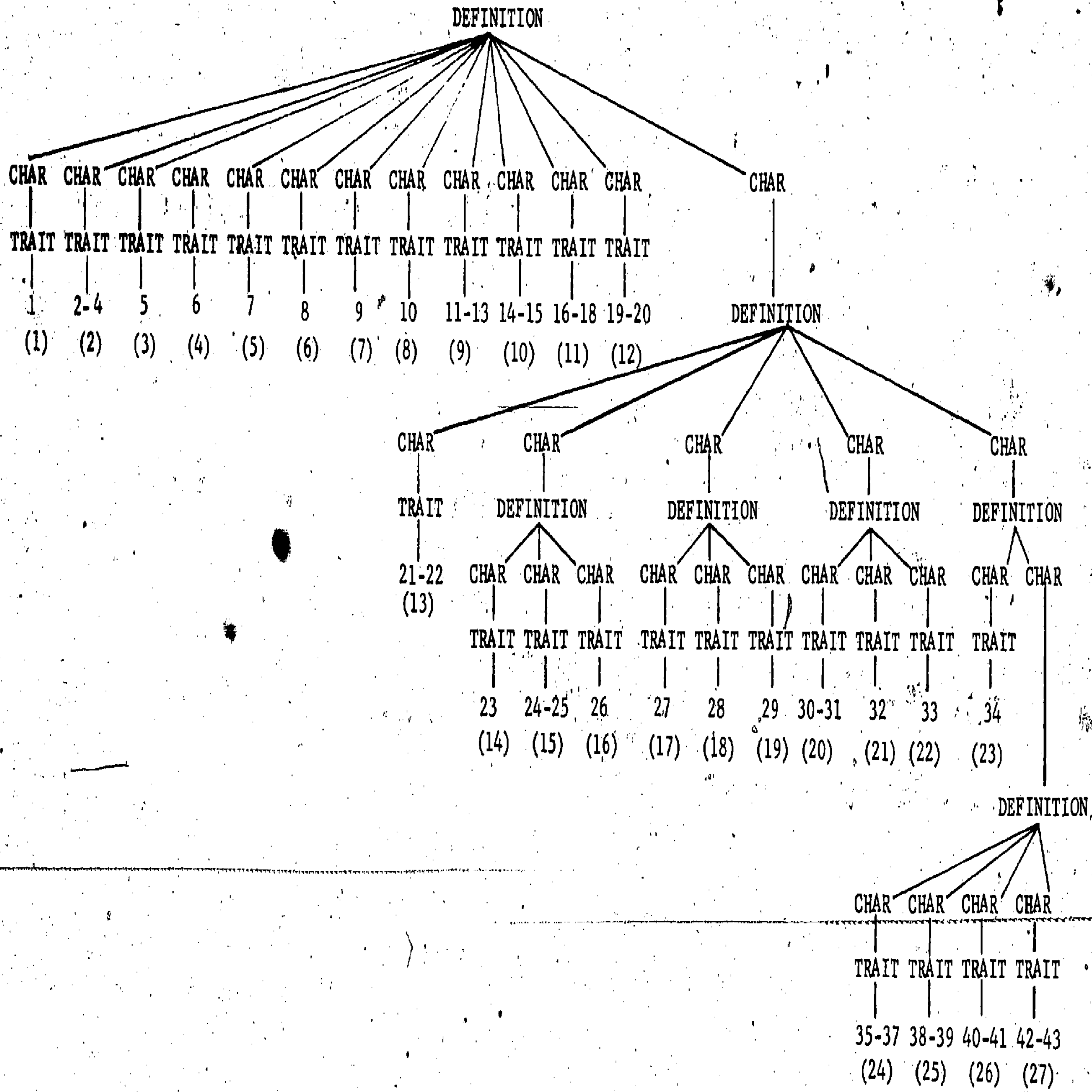

Figure 35.

The text structure for "Nematodes."

Note: CHAR = CHARACTERISTIC.

```
NEMATODES THAT ARE PARASITIC ON PLANTS (x)
        is when
TINY (x)
PARASITIC-ON (x, PLANTS)
TRANSLUSCENT (x)
ROUNDWORM (x)
SELDOM (MORE (LONG (x), LONG (1/16")))
GENERAL (THREADLIKE (FORM (x)))
INFEST (SPECIES (x) (NUMBER (SPECIES (x), NEARLY 2000)), ROOTS (PLANTS))
INFEST (SPECIES (x) (NUMBER (SPECIES (x), AT LEAST 200)), ABOVE-GROUND-PARTS
        (PLANTS))
EXIST-IN (x, AND (CLIMATES (NEARLY ALL (CLIMATES)), GARDENS (ALL (GARDENS))))
NOT (EVERYWHERE (SERIOUS-PESTS (x)))
OFTEN (PROBLEM-ON (x, OLD-AGRICULTURAL-LAND (CONVERTED-TO (OLD-AGRICULTURAL-
        LAND, HOUSING))))
IN (AND (MORE (FAST (INCREASE (x))), MORE (DAMAGE (x))), AND (MORE (WARM
        (CLIMATE)), MORE (WARM (SEASON))))
MOST (COMMON (x (ROOT-INFESTING (x))))
MOST (WIDESPREAD (x (ROOT-INFESTING (x))))


ROOT-INFESTING NEMATODE (x)
        is when
INFEST (x, ROOTS (PLANTS))
MOST (COMMON (PLANT-DAMAGING NEMATODE (x)))
MOST (WIDE SPREAD (PLANT-DAMAGING NEMATODE (x)))
OR (ENDOPARASITE (x), ECTOPARASITE (x))
USE (x, STYLET, SUCK OUT (x, CONTENTS (CELL (PLANT))))
RESULT (x, DAMAGED (ROOT SYSTEM))


STYLET (x)
        is when
USE (ROOT INFESTING NEMATODE, x, SUCK OUT (ROOT-INFESTING NEMATODE, CONTENTS
        (CELL (PLANT))))
KIND (HOLLOW SPEAR (x))
WHILE (FEED (ROOT-INFESTING NEMATODE), EXTEND (ROOT-INFESTING NEMATODE, x))


ECTOPARASITE (x)
        is when
ROOT-INFESTING NEMATODE (x)
REMAIN (x, OUTSIDE IN SOIL)
FEED-AT (x, SURFACE (PLANT))


ENDOPARASITE (x)
        is when
ROOT-INFESTING NEMATODE (x)
ENTER (x, ROOT (PLANT))
WHILE (HOUSED-IN (x, ROOT (PLANT), FEED (x)))
```

Figure 36 (part I). The semantic representation of "Nematodes."

```
DAMAGED ROOT SYSTEM (x)
        is when
RESULT (ROOT-INFESTING NEMATODES, x)
EXIST (SYMPTOMS (x))
IF (NOT (DIG UP (?, PLANT)), POSSIBLE (SEE (?, SOME *SYMPTOMS (x))))

SYMPTOMS OF DAMAGED ROOT SYSTEM (x)
        is when
IF (NOT (DIG UP (?, PLANT)), POSSIBLE (SEE (?, SOME (x))))
INCLUDE (SOME (x), SLIGHT LEAF DISCOLORATION)
INCLUDE (SOME (x), GROWTH (OR WEAK (GROWTH), REDUCED (GROWTH))))
INCLUDE (SOME (x), POOR PRODUCTION (OR (FLOWER, FRUIT))
INCLUDE (SOME (x), WILTING (ON HOT DAYS (OFTEN (DURING NIGHT, NOT (RECOVER-
        FROM (PLANT, WILTING))))))
```

Figure 36 (part II). The semantic representation of "Nematodes."

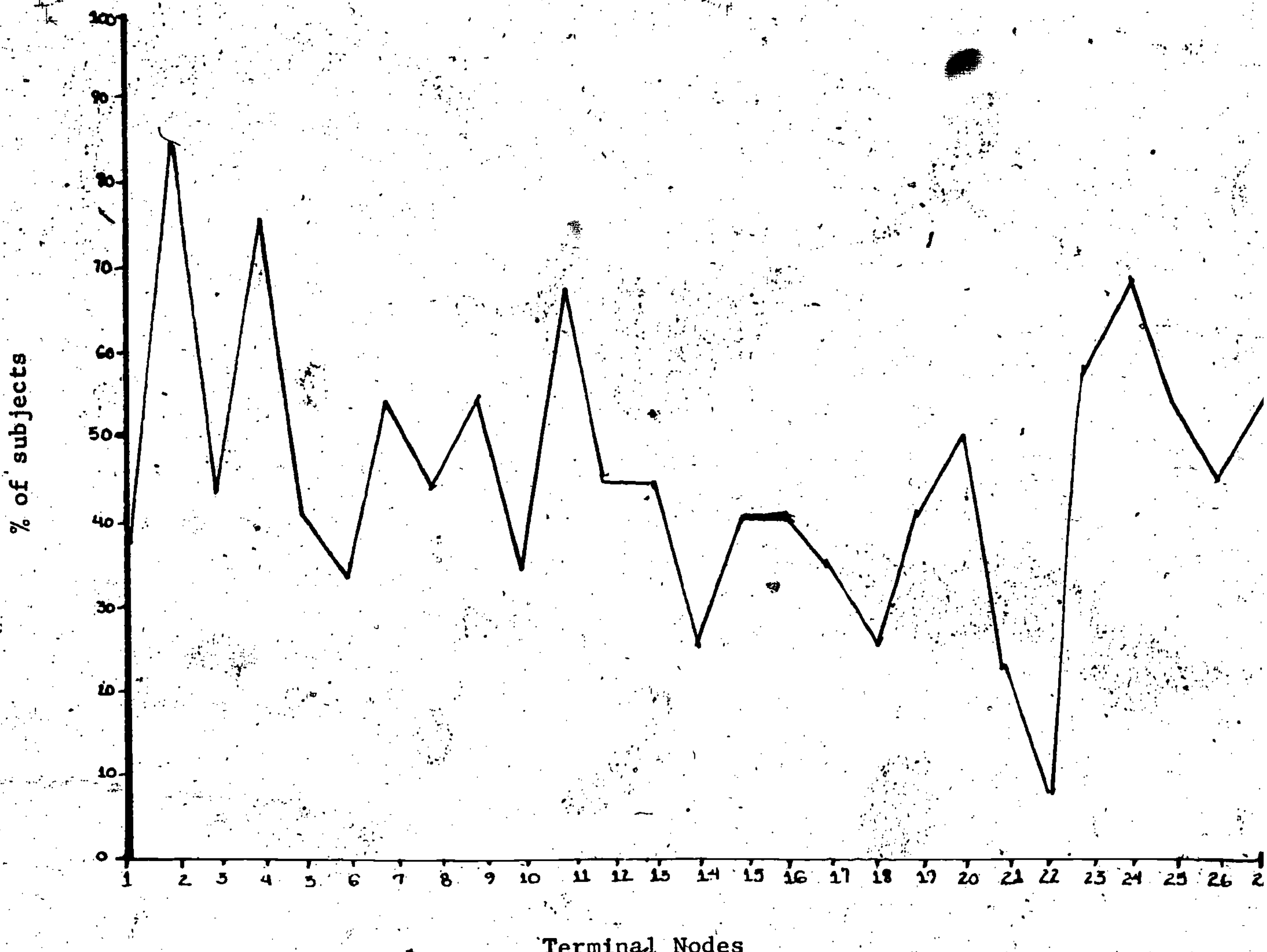

Figure 37. % of subjects who included terminal nodes in summary of "Nematodes."

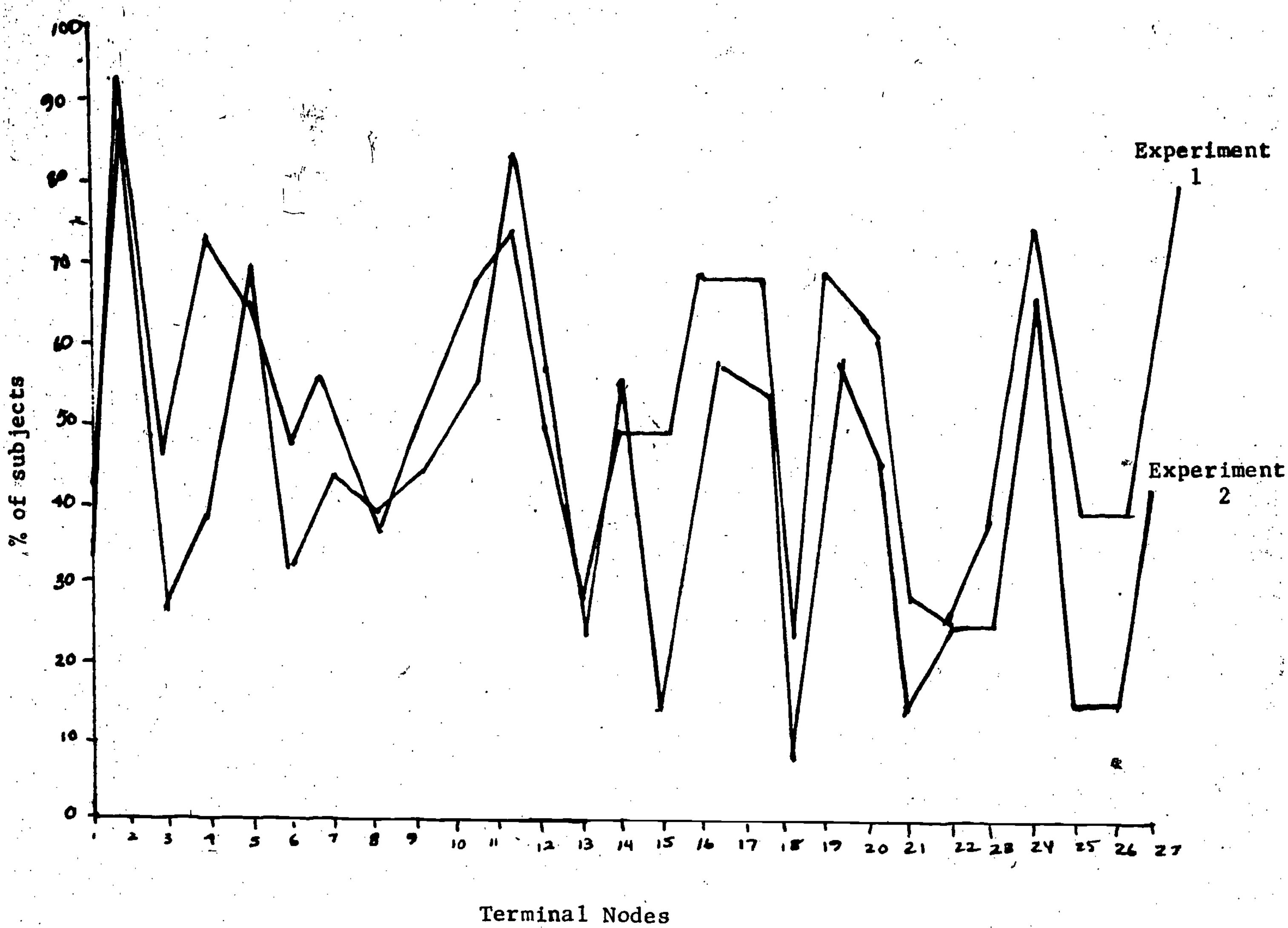

Figure 38. % of subjects recalling each terminal node of "Nematodes."

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Text A-5

Courtly Love (definition)

1. What was courtly love?
2. It was a system
3. or cult of love,
4. more easily described
5. in its several characteristics
6. than defined.
7. First of all, it was a sentiment of a specialized kind,
8. which was created by the poets at a particular period.
9. It was predicated upon a recognized social structure:
10. a court,
11. lords
12. and ladies,
13. retainers
14. attached to the court;
15. in short, the feudal society.
16. An aristocratic cult,
17. it excluded from its mysteries all those of common birth
18. or humble station.
19. Only the "gentle" were capable of love,
20. and not all of those,
21. for the perfect knight was compelled
22. to follow carefully the prescribed ritual of the cult.
23. The service of love, indeed, was like that of the vassal to his lord:
24. the lover must be subservient to the desire,
25. even to the whim of his lady.
26. "Courtesy"
27. and humility were among the chief characteristics of this love.
28. Courtesy could be attained usually only by the knight
29. who was well-born
30. and trained in courts.
31. It was conferred by love
32. and demanded gentility.
33. The knight swore
34. to protect all gentle ladies
35. (but not all women)
36. and to obey...(36)...the commands of his lady in the service of love.
37. without question
38. He followed her every caprice
39. and against her displeasure he had no defense.
40. He must lay his devotion
41. humbly
42. and his life...(42)...at his lady's feet.
43. (if necessary).
44. With great humility
45. he must accept her praises
46. and condemnations alike.
47. He reverenced her almost as a diety.

'Courtly Love'

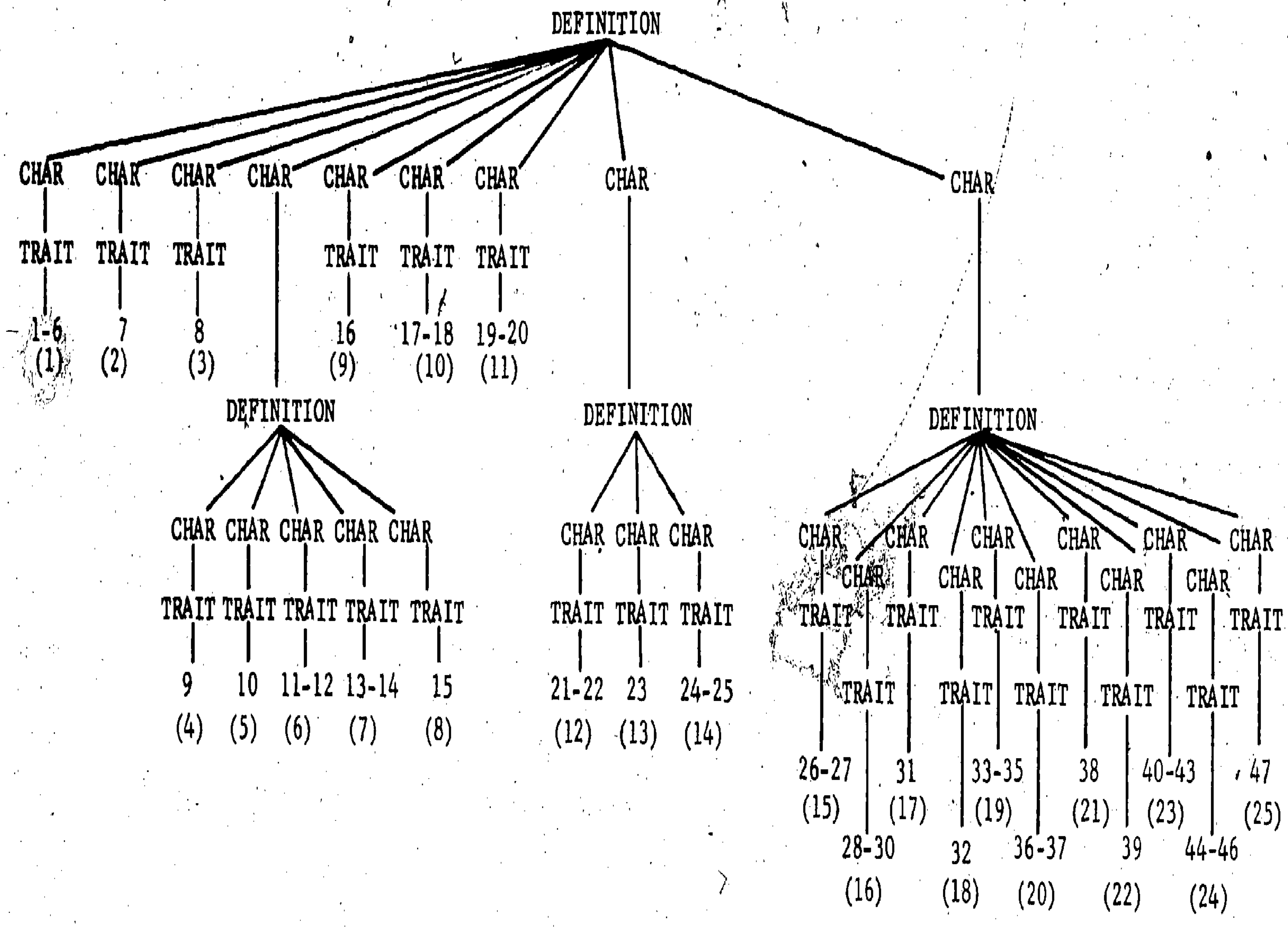

Figure 39.

The text structure for "Courtly Love."

Note: CHAR = CHARACTERISTICS.

```
COURTLY LOVE (x)
        is when
OR (LOVE-SYSTEM (x), LOVE-CULT (x))
MORE (EASY (DESCRIBE (?, CHARACTERISTICS (x))), EASY (DEFINE (?, x))
SPECIALIZED-SENTIMENT (x)
CREATE (POETS (PARTICULAR PERIOD), x)
PREDICATE-ON (POETS, x, FEUDAL SOCIETY)
ARISTOCRATIC-CULT (x)
EXCLUDE (x, FROM MYSTERIES (x), OR (PEOPLE (COMMON-BIRTH), PEOPLE
        (HUMBLE STATION)))
CAPABLE-OF (NOT (ALL (GENTLE), x)
COMPEL (x, PERFECT-KNIGHT, CAREFUL (FOLLOW (PERFECT-KNIGHT, RITUAL (x)))
BE LIKE (SERVICE (x), SERVICE-TO (VASSAL, LORD))
CHIEF-CHARACTERISTICS (x, AND (COURTESY, HUMILITY))
CONFER (x, COURTESY)


FEUDAL SOCIETY (x)
        is when
RECOGNIZED-SOCIAL-STRUCTURE (x)
COMPOSED-OF (x, AND (COURT, AND (AND (LORDS, LADIES), RETAINERS
        (ATTACHED-TO (RETAINERS, COURT)))))


PERFECT-KNIGHT (x)
        is when
CAPABLE-OF (x, COURTLY LOVE)
LOVER (x)
GENTLE (x)
COMPEL (COURTLY LOVE, x, CAREFUL (FOLLOW (x, RITUAL (COURTLY LOVE))))
BE SUBSERVIENT (x, DESIRE (LADY (x)))


BE SUBSERVIENT (x, WHIM (LADY (x)))
ATTAIN (ONLY (x), COURTESY)
WELL-BORN (x)
TRAINED (x IN COURTS)
SWEAR (x, PROTECT (x, ALL (GENTLE LADIES)))
NOT (SWEAR (x, PROTECT (x, ALL (WOMEN))))
SWEAR (x, WITHOUT QUESTION (OBEY (x, COMMANDS (LADY (x) INSERVICE OF LOVE))))
FOLLOW (x, ALL (CAPRICE (LADY (x)))
NOT (DEFEND-US (x, DISPLEASURE (LADY (x))))
HUMBLE (LAY (x, DEVOTION (x), AT FEET (LADY (x))))
IF (NECESSARY (LAY (x, LIFE (x), AT FEET (LADY (x)))), LAY (x, LIFE (x)
        AT FEET (LADY (x))))
HUMBLE (ACCEPT (x, AND (PRIASES (LADY (x)), CONDEMINATIONS (LADY (x)))))
LIKE (REVERENCE (x, LADY (x)), REVERENCE (x, DEITY)


COURTESY (x)
        is when
CHIEF CHARACTERISTICS (COURTLY LOVE, AND (x, HUMILITY))
ATTAIN (ONLY (PERFECT-KNIGHT, x))
CONFER (COURTLY LOVE, x)
DEMAND (x, GENTILITY)
```

Figure 40. The semantic representation of "Courtly Love."

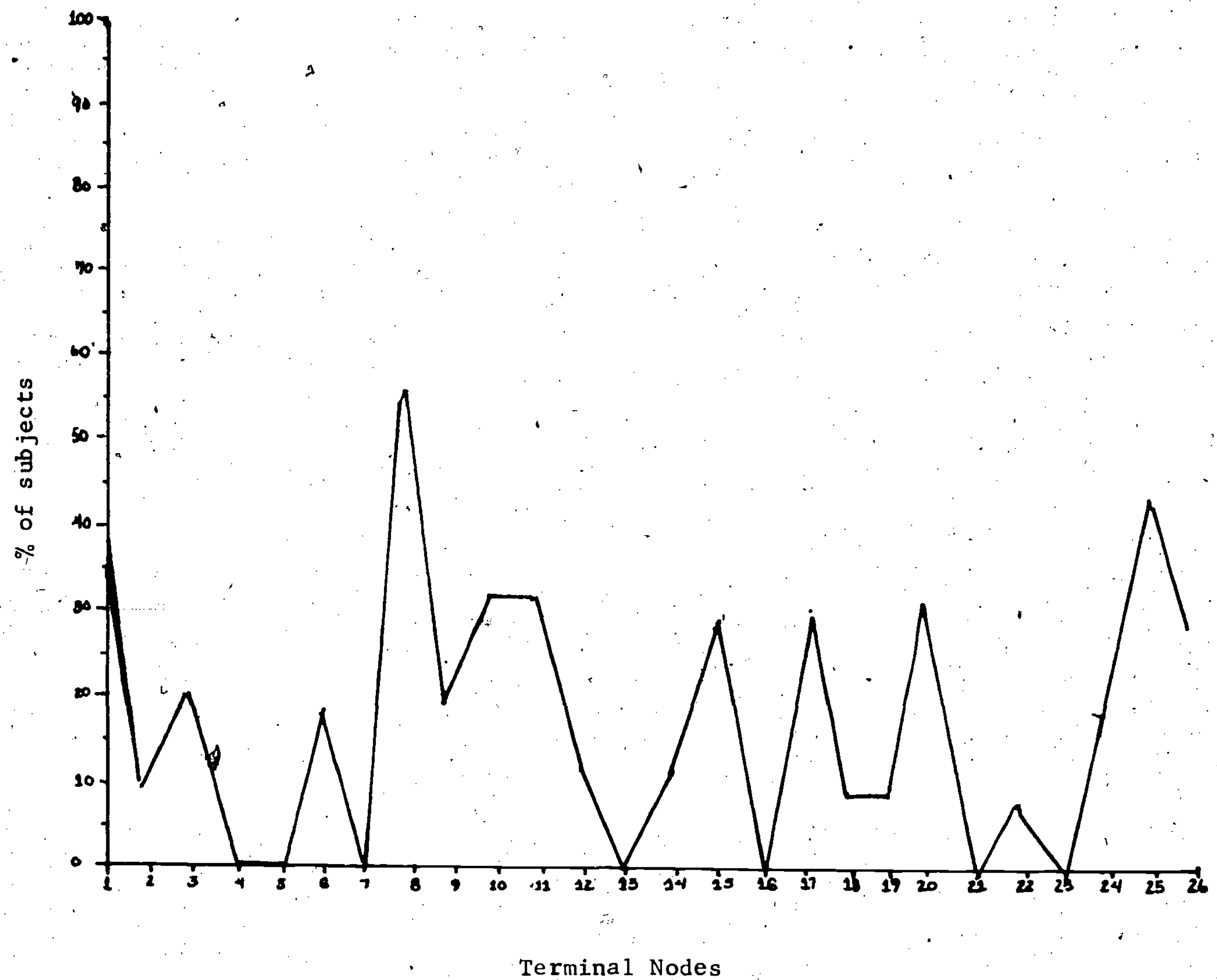

Figure 41. % of subjects recalling each terminal nodes of "Courtly Love."

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