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ABSTRACT

The question of how people learn and remember information from complex written materials is explored by means of Grime's semantic grammar of propositions and the author's analysis of the content structure of prose. This paper, presented at the 1973 Interdisciplinary Meeting on Structural Learning, first discusses such elements of the semantic grammar of propositions as rules of the grammar, lexical predicates, and rhetorical predicates; it then provides a procedure for the analysis of prose and demonstrates the procedure in an analysis of an exemplary paragraph. Charts, diagrams, and a list of sixteen references are included. (SRW)

STRUCTURE OF PROSE: IDENTIFICATION AND EFFECTS ON MEMORY

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Structure of Prose: Identification and Effects on Memory

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The question of how people learn and remember information from complex written materials has long been of interest to psychologists and educators. A comprehensive investigation of this question has been delayed due to the complexity of prose materials and the lack of skills necessary to control the variance of prose. A primary limitation of those studies which have used natural prose as the learning stimulus is that the results obtained from one passage cannot be generalized to another passage since the variables on which the passages are similar or different have not been specified. Attempts have been made in the past to categorize prose by assessing its readability through such measures as sentence length, vocabulary, density and rarity, and idea density. These measures have had limited success since they deal with surface factors of the prose and are not concerned with the meaning of prose and the manner in which the content is organized to convey this meaning to the reader. Recent work by linguists (Fillmore, 1968; Longacre, 1968; Halliday, 1968; Frantz, 1970; Grimes, 1972) has dealt with meaning in prose and how relationships among ideas in prose build upon each other to convey a message. Relationships among ideas in language have been specified for use in analyzing and diagraming sentences and passages. Thus, useful frameworks have recently been provided from which to investigate organization in prose.

I have found Grime's (1972) semantic grammar of propositions particularly useful in analyzing the organization of a passage's content. Utilization of this grammar produces hierarchically arranged tree structures. Nodes in these tree structures contain content words from the passage, and the lines among the nodes show spacially how the content is organized. In addition, labels are found in the tree structures which explicitly state and classify the relationships among the nodes. I call this hierarchically arranged structure of the passage's content the content structure. This type of structure has been previously called the logical structure and the semantic structure. These terms are easily confused with the structure in a person's memory. Therefore, to disambiguate these terms, a passage's structure will be referred to as the content structure since it shows the structure of the content of a passage.

Although I have made some changes in the use of the semantic grammar of propositions for prose analysis, the basic tenets outlined by Grimes have been followed. My (Meyer, 1971) first attempt at identifying the organization in prose utilized an intuitive procedure which produced structures equivalent to the structures arrived at by the more objective procedure of the semantic grammar of propositions. People appear to have

similar intuitive knowledge of the content structure of a passage as indicated by a 91.5% average agreement among the structures made intuitively by three independent judges for two passages (Meyer, 1971). Also, the content structure is useful in predicting what information will be learned and retained from prose. In a previous study (Meyer and McConkie) it was found that information at the top nodes of a passage's content structure was recalled better than information low in the structure. The content structure appears to differentiate between what educators have referred to as the gist or the main ideas of a passage and what they have referred to as the details in a passage. The main ideas are found at the top nodes of the hierarchical, content structure and details are found at the low nodes.

This paper will cover three areas. First, the semantic grammar of propositions will be described. Second, I will explain how to use this grammar to diagram the content structure of prose. Third, some experiments using the content structure of prose will be discussed briefly.

The Semantic Grammar of Propositions

Rules of the Grammer: The semantic grammar of propositions consists of two rules, the Predicate Rule and the Argument Rule. The Predicate Rule explains that a proposition is made up of a predicate, or relation, and its argument. (The term, predicate, refers to its use in logic (Carnap, 1958), and does not mean verb.) The Predicate Rule is $F \rightarrow p_1^* \; A_0^*$.

F stands for Form. It represents a proposition and one rewrite rule that replaces F by one or more (*) predicates, p, together with zero or more arguments, A. When analyzing a passage, one considers the whole passage as F, one complex proposition. The Argument Rule shows that A is a dummy symbol and can be replaced by another F, a referential index, i, or both. This substitution situation is shown with the linked parentheses in the Argument Rule, $A \rightarrow (F \mid i)$. A referential index, i, stands for the thing to which the author is referring. The terminal (p, i) and nonterminal symbols (F, A) in the Predicate and Argument Rules enable the grammar to produce or analyze prose of any complexity or length.

The predicates referred to are of two types: lexical predicates and rhetorical predicates. The lexical predicates are related to their arguments by specific semantic roles or cases, while the rhetorical predicates are not related to their arguments by these specified roles.

Lexical Predicates: They are related to their arguments by specific semantic roles. Lexical predicates are often verbs and their adjuncts that are actually present in a passage. The lexical predicates have particular roles that they must take as arguments, other roles that they may take as arguments, and still others which they cannot take as arguments. Several recent papers (Perfetti, 1972; Rumelhart, Lindsay and Norman, 1972; Kintch, 1972) have dealt with role relationships when explaining the use of Fillmore's (1968) case grammar. Linguists vary on the labels given to identify role

or case relationships, but the underlying prineiple of identifying the function of information is the same. I use Grimes' (1972) role system which includes the roles, Agent, Patient, Experiencer, Instrument, Goal, Source, Noninstigative Cause, Range, Benefactive, Factitive and Essive. In addition, I have added Manner and Time to the list of roles. Table 1 gives a brief description of these roles. The list of roles is meant to be exhaustive and often distinctions among roles are not necessary. For example, in the sentence, PARAKEETS WERE BROUGHT TO EUROPE FROM AUSTRALIA BY JOHN GOULD IN 1840, the same argument, EUROPE, is related to the lexical predicate, BROUGHT, as both a Goal and a Range. Some linguists may give a new name to the relationship between a lexical predicate and its argument when the distinction between two or more existing roles collapse for the particular relationships, such as the collapse in Goal and Range distinctions for EUROPE in relation to BROUGHT. Instead, I signify this situation with a Goal, Range label in the content structure. In the exemplary sentence, only the role, Patient, is required for the lexical predicate, BROUGHT, and the other roles filled in the sentence are optional. Figure 1 shows the content structure of this sentence. The tree structure is northwest rooted, rather than the conventional north rooted tree due to facilitating typing of the trees.

Figure 1

KEY

CAPITALIZED WORDS = WORDS FROM THE PROSE

CAPITALIZED WITH DASHED UNDERLINING = LEXICAL PREDICATES

small case lettered words = role relationships

Rhetorical Predicates: They are not related to their arguments by specified roles. Rhetorical Predicates are primarily responsible for giving prose its overall organization. They relate together lexical propositions (lexical predicates and their arguments) and also rhetorical propositions (rhetorical predicates and their arguments). Rhetorical predicates are a small number of explicit organizing relations in prose. Although other psychologists (Crothers, 1972; Fredericksen, 1972) have used role relationships in their analyses of prose, they have not identified and used an explicit classification system of relationships at this level.[1]

[1] Fredericksen (personal communication) is developing a system of logical relations at this level.

TABLE 1

Role Relationships

Agent	Animate instigator of an action
Experiencer	Living thing that perceives an action (examples: thing that knows, feels, hears thinks)
Noninstigative Cause	Inanimate cause of an action
Instrument	Something <u>used</u> inanimately to perform an action
Patient	Who or what is directly affected by an action
Benefactive	Someone or something on whom an action has a secondary effect, good or bad
Goal	Where (person, place or thing) an action is headed or where it ends up
Source	Where (person, place or thing) an action begins
Range	Place where an action is carried out
Time	Time in which an action is carried out
Factitive	Result of an action
Manner	Way an action is performed (examples: carefully, slowly)
Essive	Identifies an animate or inanimate thing with its properties. (Thing and properties are linked together with words like <u>have</u> and <u>be</u> [Langendoen, 1970].)

Building on the work of Fuller (1958), Grimes has developed a classification of rhetorical predicates. There are three kinds of rhetorical predicates, Paratactic, Hypotactic, and Neutral. Paratactic rhetorical predicates have at least two arguments of equal weight; for example, a passage stating a problem and then the solution to the problem has a paratactic rhetorical predicate called Covariance with the two equally weighted arguments, problem and solution. In contrast, the arguments of the hypotactic rhetorical predicates are not of equal weight. One argument is superordinate to the other argument(s) that describes or gives further information about it. For example, a passage that states a problem and then gives more information about this problem has the hypotactic rhetorical predicate, Specific, where the statement of the problem is the superordinate argument and the details about the problem comprise the subordinate arguments. When diagraming the content structure of a passage the arguments of the paratactic rhetorical predicates are located at the same level of nodes in the hierarchical structure, while the superordinate argument of the hypotactic predicate is placed at a level higher in the tree structure than the hypotactic predicate's other arguments.

The third kind of rhetorical predicates, neutral rhetorical predicates, can take either a hypotactic or a paratactic form depending on the content of the arguments and the emphasis given to them by a passage's author. For example, Collection is a type of neutral rhetorical predicate. Collection is used to show that a list of elements is in some manner related into a group. This neutral predicate, Collection, can take either a paratactic or a hypotactic form. The Collection rhetorical predicate takes a paratactic form when all of its arguments are of equal weight like the list of colors in the sentence, COLORS OF PARAKEETS INCLUDE VIOLETS, BLUES, GRAYS, GREENS, YELLOWS, WHITES AND MULTI-COLORED VARIATIONS. The Collection rhetorical predicate takes a hypotactic form when one argument of a collection is singled out and the other arguments are presented in relation to this prominent argument. The argument, THE ORIGINAL LIGHT GREEN-BODIED AND YELLOW-FACED BIRDS, is the superordinate argument in the sentence, IN ADDITION TO THE ORIGINAL LIGHT GREEN-BODIED AND YELLOW-FACED BIRDS, COLOR OF PARAKEETS INCLUDE VIOLETS, BLUES, GRAYS, GREENS, YELLOWS, WHITES AND MULTI-COLORED VARIATIONS, where the neutral rhetorical predicate, Collection, takes a hypotactic form.

This rhetorical predicate, Collection, is of particular interest since a sequence of events is depicted in a content structure as a Collection with indices for time using Litteral's Time Typology (Litteral, 1971). Litteral's system calls for making a time line for each passage and assigning numbers to the various events in concordance with their sequence of occurrence. The numbers appear in the content structure next to the arguments that they categorize for time. The other specific rhetorical predicates that fall under either the paratactic, hypotactic or neutral classifications are listed in Table 2 along with a brief description of each.

TABLE 2

Rhetorical Predicates

Paratactic Rhetorical Predicates	Description
Alternative	Equal weighted alternative options
Response	Equal weighted Question(s) and Answer(s), Remark and Reply, or Problem(s) and Solution(s)

Hypotactic Rhetorical Predicates	Description
Attribution	Describes qualities of person, place or thing
Equivalent	Restates same information in a different way
Specific	Gives more specific information about something that was stated in a more general manner
Explanation	Previously stated information is explained in a more abstract manner (for example: relating the information to a general principle) or more concrete manner
Evidence	Evidence through perception of a situation to support some idea
Analogy	Analogy given to support an idea
Setting Location	Gives location of setting in which information being related occurs (used particularly in narratives)
Setting Time	Gives time of setting in which information being related occurs (often in narratives)
Setting Trajectory	Gives changing background of location and time that occurs in a narrative when characters travel through various places
Representative Identification	Singles out one element of a group and makes it stand for the group as a whole
Replacement Identification	One thing standing for something else
Constituency Identification	Identifies a part in relation to some whole

Neutral Rhetorical Predicates	Description
Collection	List of elements related in some manner
Covariance	Relation often referred to as condition, result, or purpose with one argument serving as the Antecedent and the other as the Consequent, result of the antecedent
Adversative	Relates what did not happen to what did happen

Procedure for Analysis of Prose and Exemplary Paragraph

Analysis of prose into its content structure, the hierarchical diagram showing the organization of a passage's content, begins by careful readings of a passage. The following paragraph will be diagramed into its content structure to exemplify the analysis procedure.

Parakeet Paragraph

> The wide variety in color of parakeets that are available on the market today resulted from careful breeding of the color mutant offspring of light green-bodied and yellow-faced parakeets. The light green body and yellow face color combination is the color of parakeets in their natural habitat, Australia. The first living parakeets were brought to Europe from Australia by John Gould, a naturalist, in 1840. The first color mutation appeared in 1872 in Belgium; these birds were completely yellow. The most pupular color of parakeets in the United States is sky-blue. These birds have sky-blue bodies and white faces; this color mutation occurred in 1878 in Europe. There are over 66 different colors of parakeets listed by the Color and Technical Committee of the Budgerigar Society. In addition to the original light green-bodied and yellow-faced birds, colors of parakeets include varying shades of violets, blues, grays, greens, yellows, whites and multi-colored variations.

1. Diagraming Each Sentence: Begin by writing down the first sentence in the passage. If it is a complex or compound sentence, write it again in simple sentences. Then, diagram each simple sentence, or lexical proposition, into its lexical predicate and its role related arguments.

This procedure was followed for sentence 1 in the Parakeet paragraph as seen in Figure 2- 1a. The original complex sentence was rewritten as two simple sentences, and each simple sentence was diagramed.

2. Further Analysis of Arguments: Analyze the arguments which are rhetorical propositions to the degree of specificity desired. The rhetorical predicates, Attribution, Specific, Collection and Equivalence, are frequently found in simple sentences.

In sentences 2, 3, 7, and 8 in Figure 2, rhetorical propositions are arguments of lexical predicates. For example, in sentence 3, JOHN GOULD fills the agent role and is related to NATURALIST by the hypotactic rhetorical predicate, Attribution.

3. Identifying Rhetorical Predicates in Complex and Compound Sentences. If the passage's first sentence needed to be broken down into simple sentences, look for the words that connected the two simple sentences into a compound sentence or the words that related one clause to another in a complex

Figure 2

CONTENT STRUCTURE OF EACH SENTENCE
IN PARAKEET PARAGRAPH

1. a. The wide variety in color of parakeets that are available on the market today resulted from careful breeding of the color mutant offsprings of light green-bodied and yellow-faced parakeets.

A wide variety in color of parakeets is available on the market today. (consequent)

- IS_AVAILABLE
  - essive
    - WIDE VARIETY IN COLOR OF PARAKEETS
  - range
    - MARKET
  - time
    - TODAY

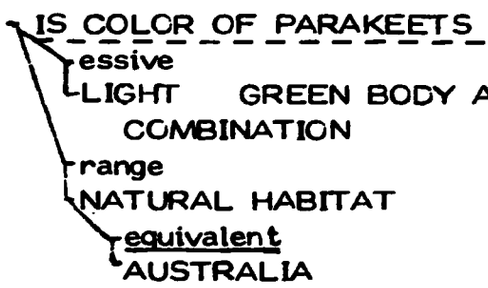
Color mutant offsprings of light green-bodied and yellow-faced parakeets were carefully bred. (antecedent)

- WERE_BRED
  - manner
    - CAREFULLY
  - patient
    - COLOR MUTANT OFFSPRING
  - source
    - LIGHT GREEN-BODIED AND YELLOW-FACED PARAKEETS

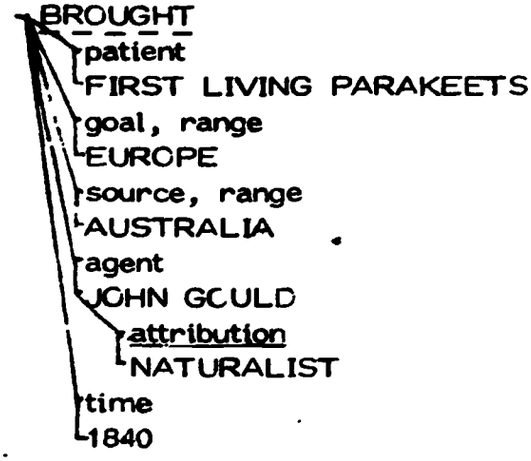
b.
- covariance, consequent*
- IS_AVAILABLE
  - essive
    - WIDE VARIETY IN COLOR OF PARAKEETS
  - range
    - MARKET
  - time
    - TODAY
- covariance, antecedent
- WERE_BRED
  - manner
    - CAREFULLY
  - patient
    - COLOR MUTANT OFFSPRING
  - source
    - LIGHT GREEN-BODIED AND YELLOW-FACED PARAKEETS

*underlined, small case lettered words = rhetorical predicates

2. The light green body and yellow face color combination is the color of parakeets in their natural habitat, Australia.



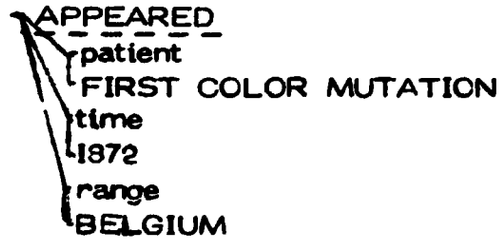
3. The first living parakeets were brought to Europe from Australia by John Gould, a naturalist, in 1840.



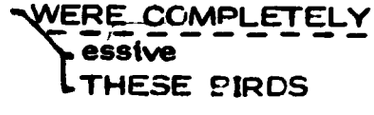
Note that sentences 2 and 3 give further information about the source in sentence 1, LIGHT GREEN-BODIED AND YELLOW-FACED PARAKEETS.

4. a. The first color mutation appeared in 1872 in Belgium; these birds were completely yellow.

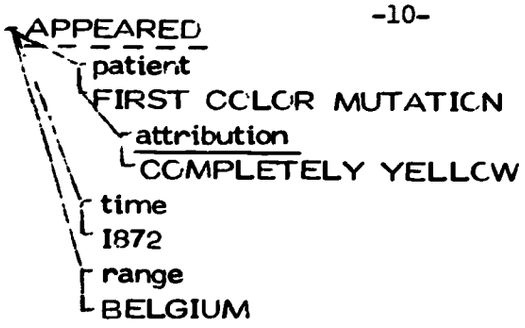
The first color mutation appeared in 1872 in Belgium.



These birds were completely yellow.



4. b

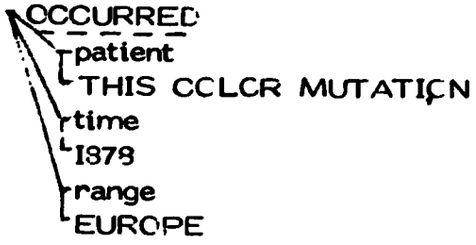


5. The most popular of parakeets in the United States is sky-blue.

6. These birds have sky-blue bodies and white faces; this color mutation occurred in 1878 in Europe.

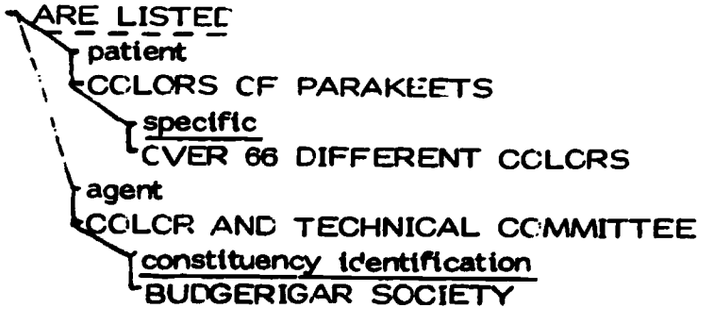
These birds have sky-blue bodies and white faces.

This color mutation occurred in 1878 in Europe.



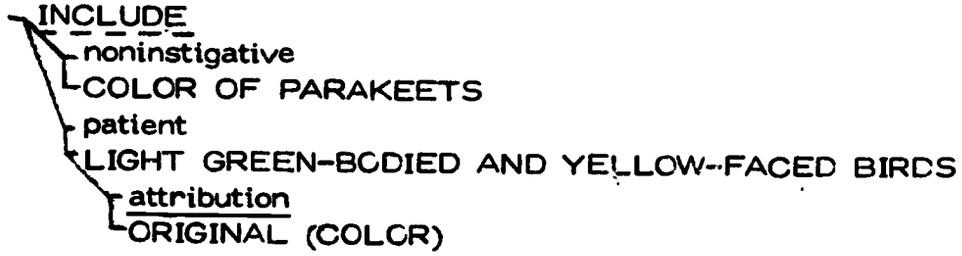
Note that sentences 5 and 6 have referential indices referring to the same referent.

7. There are over 66 different colors of parakeets listed by the Color and Technical Committee of the Budgerigar Society.

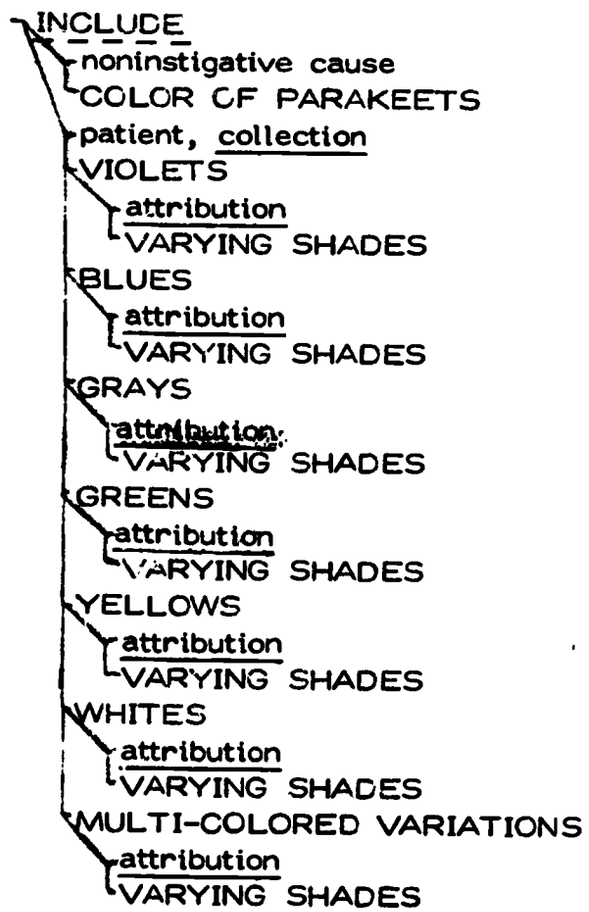


8. a. In addition to the original light green-bodied and yellow-faced birds, colors of parakeets include varying shades of violets, blues, grays, greens, yellows, whites and multi-colored variations.

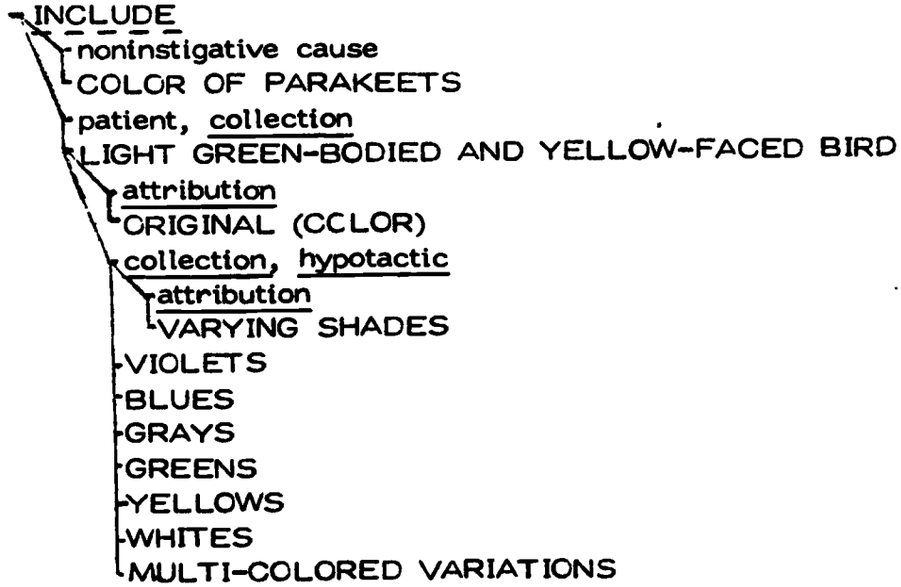
Colors of parakeets include the original light green-bodied and yellow-faced birds.



Colors of parakeets include varying shades of violets, blues, grays, greens, yellows, whites, and multi-colored variations.



8. b.



Note that sentences 7 and 8 give further information about the consequent argument in sentence 1.

sentence. These words tell how the two or more lexical propositions are related. Match this relationship with the rhetorical predicate that classifies it correctly and label the two simple sentences with the rhetorical predicate that relates them together. Then, diagram the two lexical propositions together using the identified rhetorical predicate.

The first sentence in the Parakeet paragraph is a complex sentence which can be divided into two simple sentences. These lexical propositions are related together by the rhetorical predicate, Covariance, as indicated by the word, RESULTED. In Figure 2 the first simple sentence derived from the first sentence in the paragraph is labeled the Consequent condition in the Covariance relationship and the other is labeled the Antecedent. These two lexical propositions are diagramed together in Figure 2, 1-b.

4. Referential Indices with the Same Referent: After all the sentences have been diagramed as lexical or rhetorical propositions, look for referential indices which refer to the same thing, and mark them for future use. Also, look for General/Specific relations among the referential indices. Combine lexical propositions with the same referents. These combinations are usually accomplished with the Specific or Attribution rhetorical predicates.

Sentences 5 and 6 in the Parakeet paragraph have been combined by using this procedure. The referential indices, SKY-BLUE, MOST POPULAR COLOR OF PARAKEET, SKY-BLUE BODIES WITH WHITE FACES and THIS COLOR MUTATION all refer to the same thing, the sky-blue parakeet. Thus, SKY-BLUE replaces THIS COLOR MUTATION and SKY-BLUE BODIES AND WHITE FACES comes under SKY-BLUE and is related to it by the Specific rhetorical predicate. MOST PUPULAR COLOR OF PARAKEETS falls under SKY-BLUE and is related to it by the Attribution rhetorical predicate. SKY-BLUE is a type of color mutation as indicated by THIS COLOR MUTATION and thus, this entire lexical proposition is related to the argument COLOR MUTANT OFFSPRING in the first sentence by the rhetorical predicate, Specific as seen in Figure 3.

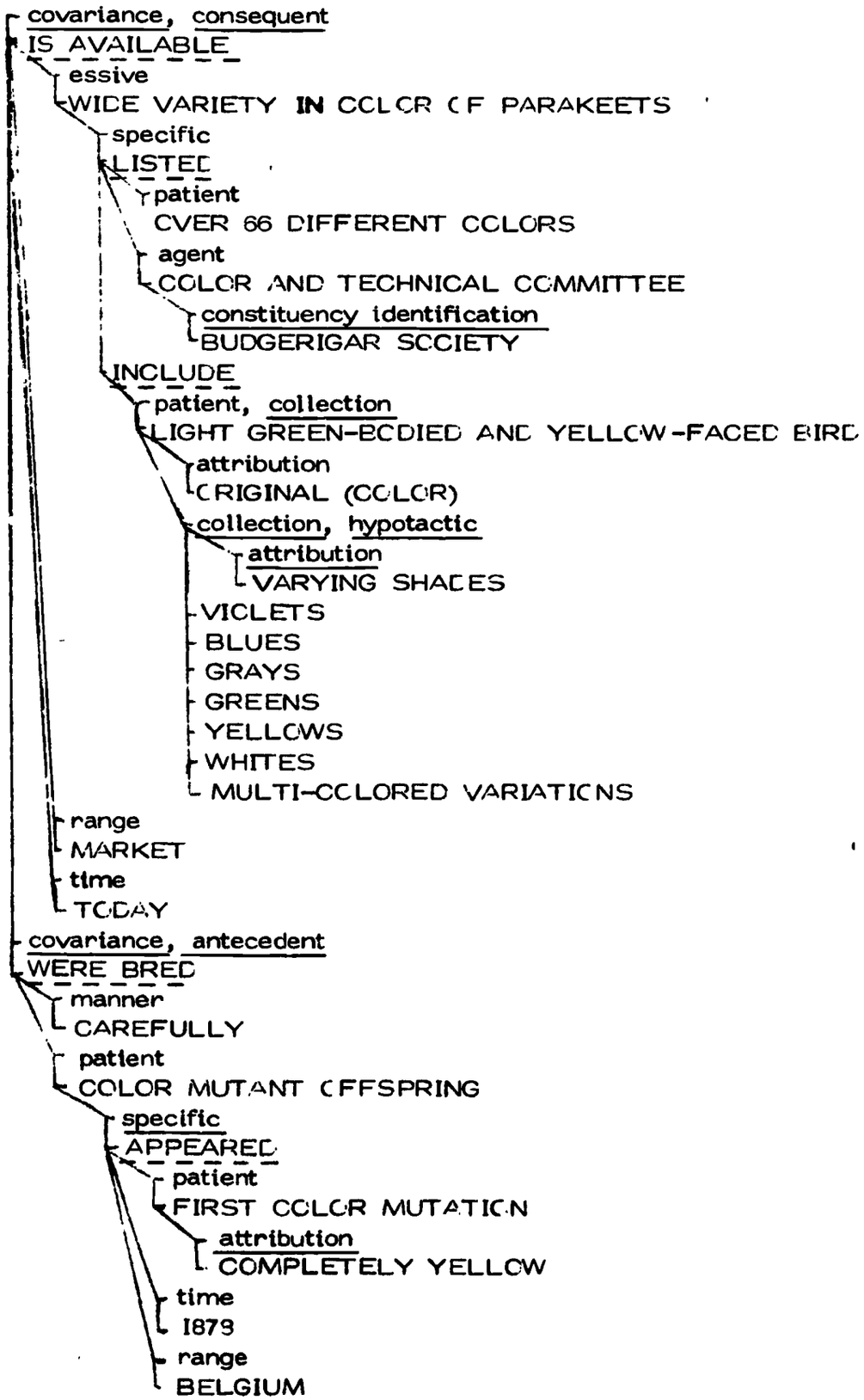
5. Identifying Other Rhetorical Predicates Among Sentences: Look for words, such as therefore, due to, and problem-answer, that can be used to determine the rhetorical predicates among lexical propositions and rhetorical propositions.

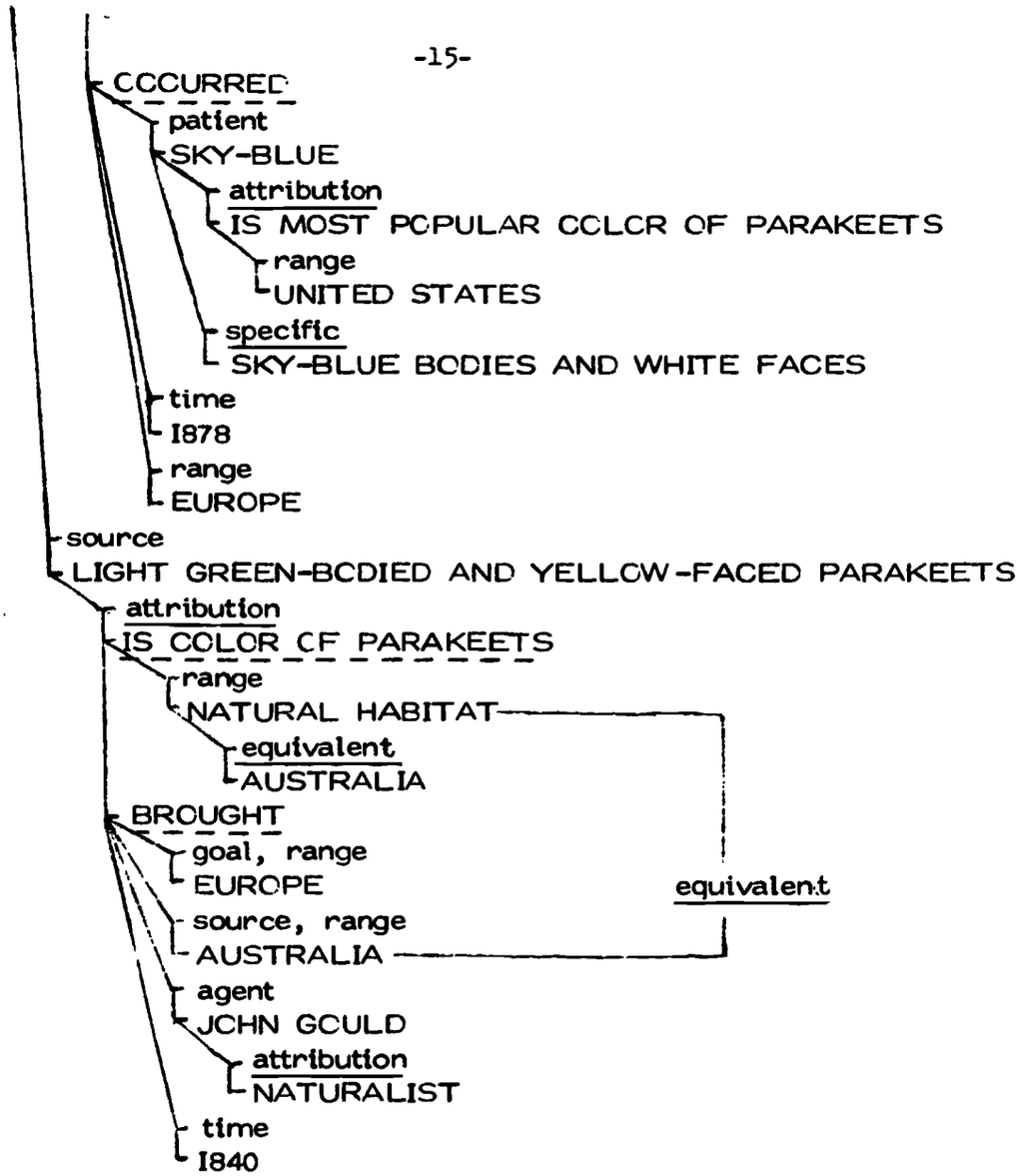
No examples are available in the Parakeet paragraph aside from those mentioned in procedural point 4. The procedure for this fifth step is similar to that followed to identify rhetorical predicates in compound and complex sentences, point 3.

6. Identification and Use of Top Level Rhetorical Structure: Look at the rhetorical predicates (or in some rare cases, role relationships if there are no top level rhetorical predicates in the sentence diagrams) that have been identified and see if there are lexical propositions that describe or give further information about the rhetorical predicate's arguments. Combine all lexical propositions and rhetorical propositions with the appropriate rhetorical predicates.

Figure 3

Content Structure of Parakeet Paragraph




CCCURRED
patient
SKY-BLUE
attribution
IS MOST PCPULAR CCLCR OF PARAKEETS
range
UNITED STATES
specific
SKY-BLUE BCDIES AND WHITE FACES
time
I878
range
EUROPE
source
LIGHT GREEN-BCDIED AND YELLOW-FACED PARAKEETS
attribution
IS COLOR CF PARAKEETS
range
NATURAL HABITAT
equivalent
AUSTRALIA
BROUGHT
goal, range
EUROPE
source, range
AUSTRALIA
agent
JCHN GCULD
attribution
NATURALIST
time
I840
equivalent

In the Parakeet paragraph, all the other lexical propositions can be placed under either the Consequent argument or the Antecedent argument of the Covariance relationship in the first sentence. These lexical propositions are related by rhetorical predicates to the arguments of the top level rhetorical predicates. Figure 3, the content structure of the Parakeet passage, shows that these lexical predicates are either related by a Specific rhetorical predicate to the proposition, WIDE VARIETY IN COLOR OF PARAKEETS IS AVAILABLE, by a Specific rhetorical predicate to the Patient in the Antecedent proposition, or by an Attribution rhetorical predicate to the Source in the Antecedent proposition.

7. Changing Some Trees to Networks: The resulting content structures of this type of analysis are usually northwest rooted tree structures. Tree structures depict the interrelationships and content well, but it is suspected that in memory knowledge structures are networks with content and relationships from prose related to a reader's previous, related information. A few of the passages which I have analyzed have required rhetorical predicate labeled loops on the right-hand side of the tree structures, turning them into networks. Thus, although tree structures are usually sufficient to display the content structure, the limitations of the tree structure and the probable network format of knowledge in memory are recognized.

A simple example of a need for a network is found in the right-hand loop between NATURAL HABITAT and the Source, Range, AUSTRALIA, in Figure 3. This loop is labeled with an Equivalence rhetorical predicate.

Use in Memory Research and Some Experimental Results

The content structure of a passage is a hierarchical diagram depicting the passage's content and its organization through the use of lines, nodes, and labels. I am assuming that the content structure is similar in some respects to a person's organization in memory of the information that he has retained from a passage. A way to study similarities between the content structure and the organization of information from prose in memory is to compare what people remember from prose to the content structure. I score recall protocols of subjects who have read a passage according to the content they can remember and whether or not they remember the relationships among the content in a passage. Thus, I score a protocol for role relationships, rhetorical predicates, lexical predicates, and referential indices.

In the previous experiment (Meyer and McConkie) where I found information high in the content structure recalled better than information low in the structure, the content of the information at high and low positions in the content structure was not controlled. Thus, the results could have been due to different types of information which may be located in high and low structural positions. In order to control for the content of information while investigating the effect of position in the content structure on what is remembered from prose, I wrote two passages each containing one identical paragraph. The passages were written so that the identical paragraph was

high in the content structure of one passage and low in the structure of the other passage. In addition, each passage was of equal length and the paragraph came at the same serial location in both passages. The identical paragraph in the two passages is the Parakeet paragraph, the exemplary paragraph analyzed in this paper. Preliminary analysis shows that the Parakeet paragraph is recalled over twice as well when it is high in a passage's content structure than when it is low in the structure. Thus, the position of information in the content structure appears to be an effective determinate of how well information will be remembered.

Other variables related to the content structure under investigation include the efficacy of certain top level structures in remembering prose content, the similarity in recall performance of passages with the same structure of relationships, but different content, and the degree to which an author explicitly reveals the content structure to his readers. In addition, aspects of the content structure may also be a useful pedagogical tool if good and poor readers differ in what they remember from the structure. In conclusion, there are potentially many uses for this content structure variable in reading and memory research concerned with ascertaining the influence of organization in prose.

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