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ABSTRACT

A propositional network system for representing the logical and semantic information contained in a text is described. The reliability of scoring information recalled from reading, using this representational system, is found to vary with the scoring goal. Determination of the amount of information recalled is found to be extremely reliable. A computer implementation is described which compares the structure of passages and that of the information recalled from them to enable research on the structure of content acquired from reading prose. (Author)

Representing Meaning in Text

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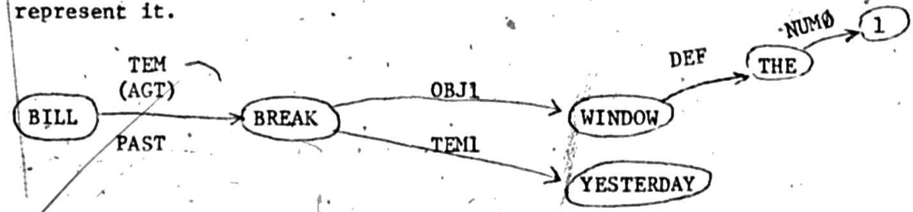
Introduction

The goal of this paper is to give an overview of the research which we have in progress on the representation of meaning in text. It should be pointed out right at the start that the thrust of the work which will be reported here has to date been primarily methodological in nature. Our current effort has been directed towards developing two components of a tool for use in psychological research. The first of these components is a notational system of sufficient generality and detail to represent a usefully-wide range of semantic information and semantic structure which we take to be a representation of the meaning of a text at a level somewhat deeper than the surface structure language representation. The second part of this tool is an accurate and reliable scoring procedure. Here we take 'scoring procedure' to mean a mapping, a way to go from the surface form of a text to a deeper level semantic representation of the text's meaning of the sort just mentioned. We have temporarily set aside questions concerning some theoretical matters such as the status of the deeper level semantic representation as a psychological model of human memory representation and questions as to the relationship of the notational system and scoring procedure to various linguistic approaches to looking at language. In this research we have taken as our starting point the work on text meaning representation of Carl Frederiksen as we felt that the notational system developed by him had good potential for meeting the criteria stated above, namely those of generality and detail, so as to be useful for the purposes of psychological research. In the course of this paper I will describe the constituent elements of Frederiksen's system in order to communicate a sense of this system's generality, that is, the kinds of semantic information it represents, and I will present one part of his system more fully as an example of the detailed semantic distinctions which are made in his notation. Following this I will give examples of some difficulties we have experienced in using Frederiksen's system in its most detailed form and will present the kinds of modifications we have made in arriving at the system of notation used in the experimental work reported by Lucas (1977), Dee-Lucas (1977) and Smith (1977). The reliability of our modified version of Frederiksen, as used in these experiments, has been the subject of some preliminary investigation and the results from this are discussed below along with several scoring guidelines which constitute our beginning attempts to improve scoring reliability and in the process to specify the relationship between surface text form and underlying semantic representation. Next I will point out the natural correspondence which exists between the basic data structure of Frederiksen's notational system, the semantic network, and some computer data structures which has led us to take advantage of a minicomputer to store our semantic content and semantic structure representations of subject recall texts. The last section of this paper will be devoted to some descriptive comments about the computer programs which we currently have available for manipulating these stored recall semantic structures. Finally, I will mention some directions which we plan to take in using the computer to discover characteristics of the structure of subject recall texts.

Frederiksen's Network Representation

Frederiksen (1975) is an ambitious attempt to develop a notational system which provides all the distinctions and notational devices needed to adequately capture the semantic and logical structure of meaning in text. Because of this, there is a depth of detail in his article which makes it impossible for me to do justice to his system in the general overview which follows. Thus, my goal here is only to characterize his work to an extent which makes the general framework of our own research clear. In the process of doing this, I will somewhat interpret Frederiksen's article at a few points.

Frederiksen (1975) describes his notational system in terms of networks, where a network is of the usual sort, that is, a set of nodes connected by labeled arcs. In his semantic networks (as opposed to logical networks, which are left for later), the nodes are filled by semantic "concepts" and the arc joining two nodes is a relation, the nature of which is specified by the arc label. Figure 1 shows a simple semantic network and a linear propositional notation we have been using to represent it.




```
P1 (:BILL)--AGT@TEM(PAST)->('BREAK)--OBJ1->(:WINDOW)
                                  /--TEM1->('YESTERDAY)

P2 (:WINDOW)--DEF->('THE)--NUMØ->('1)

    'BILL BROKE THE WINDOW'
```

Figure 1. A simple semantic network with possible text sentence and linear representation.

Two concepts and a labeled and directed binary relation form a triple, a set of which makes up a semantic network. The taxonomy of these elements of a triple is shown in Figure 2.

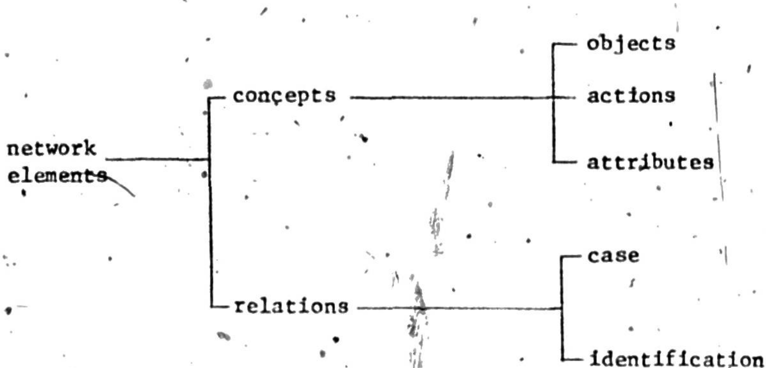


Figure 2. Taxonomy of semantic network elements.

Objects are "things which occupy space" such as 'animal', 'movie', 'wind', 'book' and 'rock' (where the single-quoted lexical items are taken to indicate the semantic concepts). Actions are "things which occupy a position or interval of time and involve change" such as 'break', 'write (something)', 'think (of something)', 'breathe', 'ride (a horse)', 'play (baseball)', 'play (with someone)', 'know (something)', and 'see (something)'. The class of attributes is not explicitly defined in Frederiksen (1975) although it is clear that it contains things like 'red' and 'quickly'.

Identifying relations are defined by Frederiksen (1975) as relations which identify an object or action (or class of objects or actions) thus serving to distinguish the object or action (or classes thereof) from others of the same type. Case relations, which "specify a causal system involving an action," are somewhat different than identifying relations as will be pointed out below.

The various kinds of concepts combine with identification relations to define several "systems", each of which specifies a different type of semantic information. Figure 3 lists the five systems thus defined by the five types of relations along with the concept types associated and the semantic information specified.

INSERT FIGURE 3 ABOUT HERE

The five identificational systems and the heretofore unused case relations combine at a next higher level of analysis to make up semantic network propositions.

Propositions are defined as representing either a state or an event. A state is an object (or object class) along with all of the identificational information represented by triples from any of the systems in Table 1 which distinguishes the object (or object class) from other classes of objects. Thus, a stative proposition, an example of which follows, represents a state so distinguished.

('the man's hair was very red in the sun yesterday.')

```
P3  (:HAIR)<-HASP--(:MAN)
          /--ATT->('RED)--DEG- ('VERY)
          /--LOC@P('IN)->('SUN)
          /--TEM->('YESTERDAY)
```

Note that this example stative proposition contains triples from only four of the five systems since manner only can apply when an action is involved.

An action, along with its obligatory and optional case relations and any identifying relations, constitutes an event. As with the stative proposition type above, an event is represented by an event proposition:

('The man dashed along the path from the door to the gate at 10 AM')

```
P4  (:MAN)--AGT->('DASH)--DAT1->(:MAN)
                          /--SOURCE->[P5]
                          /--RESULT->[P6]
                          /--TEM1->('10.AM,())
                          /--LOC1,1->(:PATH)

P5  (:MAN)--LOCØ,Ø->(:PATH)

P6  (:MAN)--LOCØ,Ø->(:GATE)
```

In this example, AGT, DAT1, SOURCE, and RESULT are case relations and TEM1 (from the temporal system) and LOC1,1 (from the locative system) are identifying relations.

In addition to the semantic network just described, Frederiksen talks about a logical network which is similar to a semantic network in form. Instead of concepts filling the network nodes, however, it is propositions that occur in these slots. The logical relation which can label the arc between two nodes can be one of three types:

logical relations
- logical
- causal
- algebraic

Just as in the semantic network, these relational types define systems which specify different types of logical information. These systems are summarized in Figure [illegible].

INSERT FIGURE 4 ABOUT HERE

Since logical networks have not been used to a large extent in our current research, I will say no more about them here.

A Modified Network Representation

One of the strengths of Frederiksen's notation is the great amount of detail the system is potentially capable of representing. This is a result of the large number of fine distinctions made in the taxonomy of concepts and the classification of relations which can co-occur with these various concept classes. The complete classification for actions, for example, in given in Figure 5 (this is Frederiksen's (1975) figure 2). Note that by making basically four distinctions (± result, ± physical, ± theme, ± simple), nine classes of actions are defined. Figure 6 presents these four choices in a systemic network to emphasize the choice systems involved in the hierarchical tree diagram of Frederiksen (fig. 5).

Let us consider only the resultive/processive action distinction for the purposes of this discussion. It was noted above that actions are characteristically associated with a set of obligatory and optional case relations, called a case system. The case system for resultive actions has the following network configuration:

```
(animate object)*-AGT-> (resultive action) ┌ OBJ1-> (inanimate object) ┐ **
      -or-                                 ├ DAT1-> (animate object)   ┘
(inanimate object)*-I-AGT->                ├ SOURCE-> [prop] *
                                           ├ RESULT-> [prop] *
                                           ├ INST-> (object)
                                           └ GOAL1-> [prop]
```

* obligatory
** one of two is obligatory
(if I-ACT is present, GOAL1 cannot be present)

The corresponding case system for processive actions is:

```
(animate object)*-PAT-> (PROCESS)- OBJ2->(inanimate object)]
      -or-                        - DAT2->(animate object)   ] **
(inanimate object)*-I-PAT->       - THEME2-> [prop] ***
                                  - GOAL2-> [prop]
```

*obligatory
**one of two obligatory if process is relative
***obligatory if process is cognitive
(if I-AGT is present, THEME2 and GOAL2 cannot be present)

My point here is not to explain the operation of the case system but rather I would like to show that the classification of a particular action as processive or resultive has a great effect on the concepts and relations used in representing an event associated with the action.

The defining features used by Frederiksen in making his taxonomic distinction, [± result] in the case under discussion, are regarded as unanalyzed primitives in his system. As a result, if there is disagreement, there is no set way for deciding when a given feature is present or absent. For an action, then, this means that it is not always clear whether the action is processive or resultive. Consequently, we don't know whether the PAT/I-PAT or AGT/I-AGT relation should be used to represent the relationship between an action and its immediate cause. For example, 'breathe' is given by Frederiksen as a processive action, one which does not produce a change in a state or other process. It would seem, however, that breathing involves changing unoxygenated blood into oxygenated blood and this looks like a change in a state, at least to some people. Again, the point here is not to get into the detailed workings of Frederiksen's semantic primitives but rather to point out that, in practice, one's intuition about semantic primitives is often an unreliable guide. It may well be the case that empirical psychological or detailed linguistic investigation is needed before a particular action can be confidently marked as + or - [result].

Our general solution to this kind of problem has been to collapse distinctions which we have trouble applying. Our current text meaning representations do not keep the processive/resultive distinction and thus we have collapsed the PAT and AGT relations into one (AGT). Note that while this results in a "modified" representation, the resultant network is not different in kind. The basic elements and structure are still the same; only the number of relations changes. The distinctions, and along with them the finer relation specifications, can easily be recovered if such distinctions prove necessary to account for effects observed in our experimental data.

I will briefly mention a second way in which we have simplified Frederiksen's notation. We have chosen to abbreviate Frederiksen's detailed representation in a number of systems by using surface text lexical items as relation modifiers. This is much as Kintsch (1974) has done in handling similar relations. Frederiksen's locative system, for example, contains some eleven relations which specify spatial position. One of these is the locative relation LOC1,1 which appears in the network for the example sentence 'the man dashed along the path...' given above. This relational label LOC1,1 specifies that the action 'dash' is located as a one-dimensional path in a one-dimensional field. The notation ('dash) - LOC1,1 -> (:path) is taken to represent the locative meaning of the surface text form 'dash along the path.' Locative propositions in English do not necessarily convey locative meaning which can so easily be represented. Often the locative relations are quite complex. To avoid having to spell out all these complexities we have used just one locative relation, LOC, and have allowed the surface text preposition to modify it. In this modified form 'dash along the path' would be represented by ('dash) - LOC@P('along)-> (:path), that is, there is a locative relation LOC between 'dash' and 'path' which is further specified as a position P of the type ('along'). Note once again that this kind of modification retains the basic form of

Frederiksen' fully detailed system and we assume that our abbreviated notation could readily be expanded into the more detailed form if this was necessary for the purposes of our psychological research.

Scoring Recalls

Earlier in this paper I defined "scoring procedure" to be the mapping which exists between the surface structure of a text and a deeper semantic level which we are representing in the manner described above. Here I would like to talk about another kind of scoring, namely that activity which a person performs when comparing a recall protocol to the semantic representation of the original or target text. In this case, the scorer is faced with a task which asks him to intuitively ascertain what semantic information is contained in the recall protocol and to decide if the same semantic information is to be found in the target semantic representation. A more rigorous way for the scorer to proceed would be for him to generate a unique semantic representation of the recall and then compare the target and recall semantic representations. Moreover, the ideal scoring would occur if we had a deterministic procedure for generating the underlying semantic representations which are to be compared. This deterministic procedure would be, in essence, a recognition "machine" or grammar and it would fully specify the kind of mapping mentioned above, i.e., the one which exists between surface structure and deep semantic structure. We, and everybody else I believe, are far from the ideal state and consequently our scoring of recalls has been of the first sort where a scorer is presented with an explicit semantic representation of the target text and asked to check the elements of it which he judges to be contained in the recall protocol, based on the surface structure text of the recall.

To test in a preliminary way whether this type of scoring is a reasonable approach productive of stable data, we undertook to determine interscorer reliability on a set of five recall protocols. Three of these protocols were taken from the data collected by Smith (1977), one immediate recall, one three-week delayed and one three-month delayed. In table 1 these are recalls A1, A2A, and A7B, respectively. Two other immediate recalls, C103 and D201, were chosen, one from Dee-Lucas (1977) and one from Lucas (1977), irrespective of experimental condition. Since we were interested in obtaining a conservative evaluation of our scoring, recalls were selected which tended to exemplify surface text characteristics which we thought would cause problems for scoring. For example, the three-month delayed recall A7B was marked by ambiguity of reference and paraphrased information related to multiple aspects of the target passage.

The five recall protocols were each scored by three scorers in the manner described above. In addition to checking as recalled elements in the target semantic representation, the scorers were allowed to record element substitutions when items in the recall protocol were taken in context to be functionally equivalent to an element in the target. For example, 'send' in a recall could take the place of 'commission' in the target in a context such as:

```
                      'SEND
(:PETER)--AGT-> ('COMMISSION)--OBJ-> (:BERING)
                            /--GOAL-> [...]
```

Equivalent substitutions were treated as checks. No strict scoring rules were specified and although the scorers were familiar with the semantic representation system used, there was no training for consistency.

Our results indicate that the reliability of this intuitive scoring varies with respect to the level of analysis. When considering the amount of information recalled in the protocol, that is, the number of elements checked in the target representation, the reliability was extremely high ($r=.99$). When considering the type of information recalled the reliability varies with the level of representation, that is, with the number of categories (for propositions $r=.84$, for elements $r=.78$).

Since we are primarily interested in research at the element level, we further undertook to discover the kinds of problems in scoring which cause variability at this level. From an analysis of the scoring data, we identified four areas of variability which we have labeled as follows:

1. scorer error (ER)
2. scorer omission (OM)
3. idiosyncratic technique (IT)
4. lack of best fit (BF)

The first two of these areas, 'error' and 'omission', are in a sense similar but we have separated them here for the purpose of determining their individual effect on reliability. Here an error is taken to be an instance where the scorer checks as present in the recall a target element which is clearly absent, while an omission is just the opposite, the scorer fails to check something clearly present. I use the term 'clearly' here to indicate that an extremely conservative criterion has been used to assign inter-scorer discrepancies to any of these categories. Discrepancies which were at all problematic were left as unresolved variability.

Category three, which was called 'idiosyncratic technique' for lack of a better term, actually contains only one way of checking found to be relatively frequent in the scoring of one scorer. In some cases what appears in a recall as an equivalent substitution can be seen as having a source in a different target proposition. For example, if 'Secretary of State' is found substituted for 'Seward' in the following context:

P7 (:SEWARD)--AGT→ ('BUY)--OBJ→ (:ALASKA)

P8 (:SEWARD)--CLAS->(:US.SECRETARY.OF.STATE)

one has sort of a 'reference chain' which one scorer attempted to capture by placing a check in P8 above.

The final category, 'lack of best fit', is somewhat more complex. It is sometimes the case that the scorers seem to agree in their identification of a piece of the surface structure of the recall text which can be matched to the target semantic representation but end up recording this in different places in the target representation. In one case the recall surface structure can be taken as ambiguous in some aspect not resolved by the context of the recall but not ambiguous when the surface structure of the target passage is considered. Take for example the following target (1) and recall (2) sentences:

(1) They [Indians] lived both on the southeast coast and in the interior region.

(2) Indians lived in the south east and middle part of area.

INSERT FIGURE 7 ABOUT HERE

Figure 7 shows the varied scoring of this case. Scorer one takes 'part' to be the head noun of two noun phrases, 'southeast(part)' and 'middle part'. Scorer two takes the two noun phrases to be 'southeast' (a substitution) and 'middle part', while scorer three analyzes the noun phrases as 'southeast(area)' and 'middle area'. The point here is that there is scoring variability even though there seems to be agreement as to the information recalled. There is, however, evidence from the target text to indicate that perhaps 'southeast' has been substituted for 'southeast coast' (a common kind of substitution) and that 'middle part of' is simply an expanded form of 'interior'. 'Area' is then left as a substitution for 'region'. The 'best fit' guideline which comes out of this reflects the fact that recalls, especially immediate recalls, tend to reflect the surface form of the target passage and that scoring should try to maximize this verbatim, in this case, structurally "verbatim" aspect as a way of resolving ambiguity.

A second type of case is also included in the 'best fit' category. As an example, examine the following target (3) and recall (4) sentences which were scored as shown in Figure 8 .

(3) They [Bering and his men] discovered St. Lawrence Island and sailed through the Bering Strait.

(4) The explorer [Bering] found the Bering Strait.

INSERT FIGURE 8 ABOUT HERE

Again, there appears to be agreement about the information to be scored. Here there is a sense in which 'sail through' is like 'discover' in the target passage and it is this that is reflected in the recall protocol. Scorer one appears to give primacy to the 'discover' - 'find' similarity, while scorers two and three seem to focus on the 'Bering Strait' identity. It would be nice to have a clear-cut way of specifying how to evaluate options like this but, unfortunately, I do not feel that we have one to offer at this time. As a preliminary step we have used a simple count of the number of equivalent substitutions involved and their degree of similarity. In this case, for example, placing the information in P251 requires three substitutions, one of which can be considered quite dissimilar ('Bering Strait' for 'St. Lawrence Island') or even non-equivalent. Placement in P252 requires only two substitutions ('find' for 'sail' or, if you would, 'sail through') since 'explorer' is clear as referentially 'Bering' from the context of the recall protocol. We realize that this sort of counting is ad hoc but it will be interesting to investigate just how far such a simple metric can take us in reducing scorer variability.

In order to see what effect the variability in each of these four categories had on the inter-scorer correlation for our sample data, we transformed the scored protocols by removing these kinds of variability, category by category. At each stage we recalculated the inter-scorer correlation and as a rough estimate of the amount of variability accounted for by each transformation, we squared the correlation and subtracted that of the previous level to arrive at a differencefigure for each level. The results from this process are presented in Table 1.

INSERT TABLE 1 ABOUT HERE

It is interesting to note that the largest amount of variability, some 17%, is due to scorer errors or omissions and that only 7% is attributable to the notation difficulties which we have identified here. We conclude from this that the most significant gains can be made by providing some scoring aids or procedure to help the scorer simply be accurate. The overall level of correlation (r=.924), or even the correlation (r=.884) at level two, is relatively high considering that it represents the strictest form of element-by-element reliability. It would appear from this that scoring of the type described here can result in data of relatively high stability considering the level of analysis.

One further comment should be made based on the data in Table 1. Recall protocol A7B is notable in that it diverges considerably from the others in scorer reliability. While it is risky to draw much of a conclusion from the evidence of one case, it may be [illegible] that long-delayed recalls (three months here) are characteristically more difficult to score reliably hence making research in this area more problematic.

Computer Implementation

The category-by-category transformation mentioned in the preceding section is just one kind of semantic network manipulation which is greatly aided by a computer software system which we have implemented on our PDP-11/40 laboratory computer. The basic core of this interactive system provides for various input/output functions, editing of input semantic structures, and scoring. At present data analysis functions are limited to 1-to-1 comparison of structures, correlations, and data summaries of the kind shown in Figures 7 and 8. This software is written in a list processing extension to FORTRAN called RT-11 SLIP which has been implemented on our machine specifically for this prose analysis system.

Although there is a convenient relationship between a network, in this case our semantic network, and the computer data structure known as a list structure (hence the RT-11 SLIP implementation), I will devote the remainder of this section to a discussion of graphs. The reason for this is that our current computer development work is aimed at implementing the software necessary for us to employ algoritms on graphs in our attempt to characterize the semantic structure of texts.

As an example, let us consider the semantic network in Figure 9a.

INSERT FIGURE 9 ABOUT HERE

This semantic network, either in its linear representation or in its node-and-arc form, is a kind of graph, namely a 'labeled network.' A graph of this sort has names uniquely identifying the nodes (1, 2, ...n) as well as labels associated with the nodes ('indian' for node 1, 'live' for node 2, ...). In addition the arcs between nodes have weight associated with them (AGT, LOC, etc.). Further, a digraph can be completely specified by a square matrix which has as many dimensions as there are unique nodes. The unweighted matrix for 9a, called simply the adjacency matrix for 9a, is shown in 9b. If an arc exists from node 1 to node 2, then there is a 1 in matrix cell 1,2, if there is an arc from 1 to 3, then there is a 1 in cell 1,3, etc., otherwise the cell is zero. There are other kinds of matrices associated with network 9a but I mention only this one since it is a simple example of how a graph operation produces what may be an interesting result. If we square the adjacency matrix, for example, then the value in some cell y_{ij} in the resultant matrix is the total number of distinct sequences, or paths, from node i to node j that have have length 2. Further powers of the matrix give the paths of lengths 3,4...n until all the cells become zero. This may seem like a difficult way of discovering paths and their lengths but this is only so for a semantic network as simple as that in Figure 9a.

Even a short and relatively simple text has a semantic network of such complexity that it makes the hand computation of paths and path lengths prohibitive in terms of time.

There are, of course, more complex algorithms on graphs, such as those dealing with connectivity, and it is these which really require the power of a computing machine. We are hopeful that the application of these algorithms will be of use in characterizing the structure of meaning in text.

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TABLE 1 - INTER-SCORER RELIABILITY
(CORRELATION COEFFICIENTS)

VARIABILITY CATEGORY

		Initial	ER	OM	IT	BF
RECALL PROTOCOL	A1	.790	.793	.865	.872	.931
	A2A	.897	.900	.923	-	-
	A7B	.442	.480	.652	-	.748
	C103	.816	.863	.914	.923	.946
	D201	.807	.833	.938	-	.968
	MEAN CORR.	.783	.806	.884	.888	.924
DIFFERENCE*			.04	.13	.01	.06

*Difference: increment in variability accounted for by eliminating each source of unreliability.

RELATIONS	CONCEPTS	SEMANTIC INFORMATION
temporal	objects	absolute time, elapsed time or duration
locative	objects, actions	location at point, on path or in region
stative	objects	part-whole, classification, attribution, symbolic content, determination, quantification
manner	actions	classification, attribution
degree	attributes	extent

Figure 3. Identificational semantic systems.

RELATIONS	LOGICAL INFORMATION
logical	conjunction, disjunction, implication, negation
causal	cause
algebraic (relative system)	equivalence, relative location, relative time

Figure 4. Logical systems.

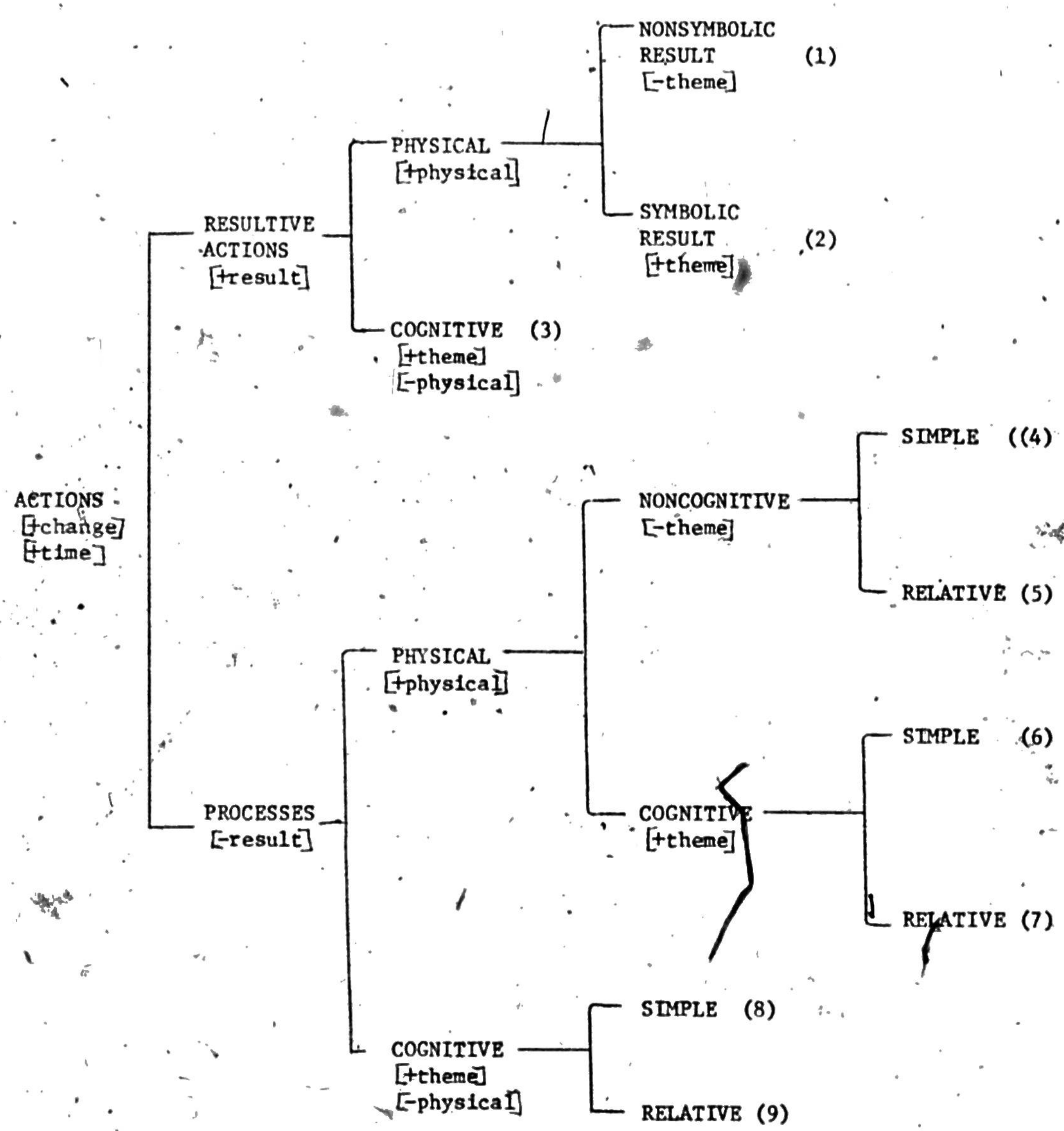


Figure 5. Action hierarchy. Examples: (1) break, give, go (somewhere), kill, build, make (something), walk (somewhere); (2) write (something), draw (something), compose (something), ask (a question), say (something); (3) think (of something), imagine (something), learn (something), remember (something); (4) breathe, sleep, walk, dance, burn, blow, grow; (5) ride (a horse), drive (a car), walk (the dog), burn (the wood), blow (the sand); (6) play (baseball), act (a part); (7) play (with someone); (8) know (something), experience (a feeling), feel (happy), believe (something); (9) see (something), understand (someone), feel (an object), like (someone or something).

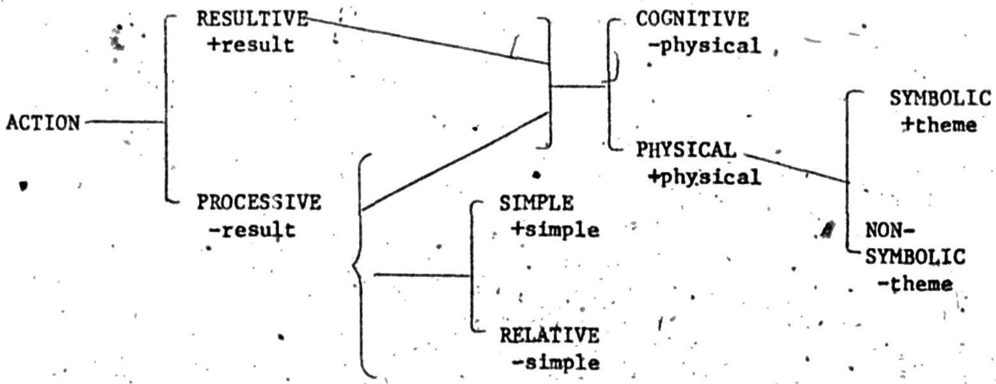


Figure 6. Systemic network representation of Frederiksen's action taxonomy. The curly bracket indicates 'and'; straight brackets represent 'or'. Thus processive actions are both +simple or -simple and +physical or -physical.

Reference prop no. P171
Reference sentence:
; 1.7 They lived both on the southeast coast and in the interior region.
Recall sentences for 1:
;1.5 The Indians lived in the south east & middle part of area.
Recall sentences for 2:
;1.5 The Indians lived in the south east & middle part of area.
Recall sentences for 3:
;1.5 The Indians lived in the south east & middle part of area.

(:INDIAN)	(:INDIAN)	(:INDIAN)	(:INDIAN)
AGT	AGT	AGT	AGT
('LIVE)	('LIVE)	('LIVE)	('LIVE)
TEM	TEM	TEM	TEM
(PAST)	(PAST)	(PAST)	(PAST)
('LIVE)	('LIVE)	('LIVE)	( )
LOC	LOC	LOC	NONE
(:COAST.1)	(:PART.1)	(:SOUTHEAST)	( )
P	P	P	P
('ON)	('IN)	('IN)	( )
('LIVE)	('LIVE)	('LIVE)	('LIVE)
LOC	LOC	LOC	LOC
(:REGION)	(:PART.2)	(:PART)	(:AREA)
P	P	P	P
('IN)	('IN)	('IN)	('IN)

Reference prop no. P172
Reference sentence:
;1.7 They lived both on the southeast coast and in the intereior region.
Recall sentences for 1:
;1.5 The Indians lived in the south east & middle part of area.
Recall sentences for 3:
;1.5 The Indians lived in the south east & middle part of area.

(:COAST.1)	(:PART.1)		(:AREA)
ATT	ATT		ATT
('SOUTHEAST)	('SOUTHEAST)		('SOUTHEAST)

Reference prop no. P173
Reference sentence:
;1.7 They lived both on the southeast coast and in the interior region.
Recall sentences for 1:
;1.5 The Indians lived in the south east & middle part of area.
Recall sentences for 2:
;1.5 The Indians lived in the south east & middle part of area.
Recall sentences for 3:
;1.5 The Indians lived in the south east & middle part of area.

(:REGION)	(:PART.2)	(:PART)	(:AREA)
ATT	ATT	ATT	ATT
('Interior)	('MIDDLE)	('MIDDLE)	('MIDDLE

Figure 7. Scoring variability for BF case 1. Column 1 on the left is the target structure. Scorers 1-3 are shown in columns 2-4 respectively.

Reference prop no. P251
Reference sentence:
;2.5 They discovered Saint Lawrence Island, now part of Alaska, and
;sailed through the Bering Strait between Asia and North America.
Recall sentences for 1:
;2.3 The explorer found the Bering straight, but couldn't see the
;N. American land mass because of fog.

(:BERING)	(:BERING)
AGT	AGT
('DISCOVER)	('FOUND)
TEM	TEM
(PAST)	(PAST)
(:MAN)	( )
AGT	NONE
('DISCOVER)	( )
TEM	NONE
(PAST)	( )
('DISCOVER)	('FOUND)
OBJ	OBJ
(:ST. LAWRENCE. ISLAND)	(:BERING. STRAIGHT.)

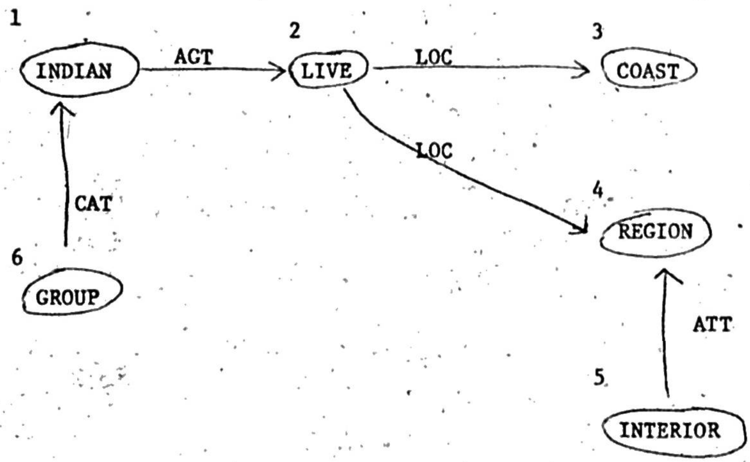
Reference prop no. P252
Reference sentence:
;2.5 They discovered Saint Lawrence Island, now part of Alaska, and
;sailed through the Bering Strait between Asia and North America.
Recall sentences for 2:
;2.3 The explorer found the Bering straight, but couldn't see the
;N. American land mass because of fog.
Recall sentences for 3:
;2.3 The explorer found the Bering straight, but couldn't see the
;N. American land mass because of fog.

(:BERING)	(:EXPLORER)	(:EXPLORER)
AGT	AGT	AGT
('SAIL)	('FIND)	('FIND)
TEM	TEM	TEM
(PAST)	(PAST)	(PAST)
(:MAN)	( )	( )
AGT	NONE	NONE
('SAIL)	( )	( )
TEM	NONE	NONE
(PAST)	( )	( )
('SAIL)	('FIND)	('FIND)
LOC	OBJ	LOC
(:BERING STRAIT)	(:BERING STRAIT)	(:BERING STAIT)
P	NONE	NONE
('THROUGH)	( )	( )

Figure 8. Scoring variability for BF case 2. Column 1 on the left is the target structure. Scorers 1-3 are shown in columns 2-4 respectively.

a.

```
(:REGION) - ATT-> ('INTERIOR)
(:GROUP) - CAT-> (:INDIAN)
(:INDIAN) - AGT-> ('LIVE) - LOC@P('ON)-> (:COAST)
                          / - LOC@P('IN)-> (:REGION)
```



b.

	1	2	3	4	5	6
1	0	1	0	0	0	0
2	0	0	1	1	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	1	0	0
6	1	0	0	0	0	0

Figure 9. a.) A semantic network with b) its corresponding adjacency matrix.