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An Evaluation of the Models of Semantic Long-Term Memory

Lutfi Ahmed Abulhaija
Assistant Professor, Department of English, Faculty of Arts & Social Sciences and Humanities, Yarmouk University, Irbid, Jordan

Abstract. The fundamental characteristics of the network models of long-term memory (LTM) is depicted as a set of locations connected by labeled associations. Similarities do exist among the network, the Set-Theoretic and the Semantic Features Models. All of these models present a theory of meaning in which a concept (or node) derives its semantic content from its relation to others. The main purpose of the present paper is to critically evaluate these models.

I. Introduction

Long-term memory (LTM) is the part of the memory system that states our knowledge of the world and that is capable of storing a great amount of information. The meanings of the words and facts are stored in LTM. The information in LTM, however, seems to be stored in a very orderly fashion.

Brown and McNeill[1] have demonstrated the regularities of LTM when they studied the "tip of the tongue" (TOT) phenomenon. The TOT state was precipitated in a given subject (S) when, having given him a definition of a low frequency word, he was asked by the experimenter (E) to try to recall the word. They showed that before the word was recalled, S had some knowledge about it. Not only did S feel he knew the word, but he could sometimes report the number of syllables, the initial sound, or where the primary stress occurred. He knew often which words were not correct and could give words that were related in meaning. In the TOT state total retrieval of the word fails, although the subject can partially retrieve the word.

(1) R.W. Brown, and D. McNeill, The "Tip of the Tongue Phenomenon," *Journal of Verbal Learning and Verbal Behavior* (1966), 325-37.

There exists a distinction in memory that has stimulated a great deal of research. This is between *Episodic* and *Semantic* Memory.(2) According to Tulving (1972), episodic memory is the one that holds temporarily coded information and events, information about how things appeared and when they occurred. It is our memory for autobiographical information. Semantic memory holds all the information we need in order to use the language. It includes words, symbols of them, their meanings and their referents, and also rules for manipulating them. Episodic and semantic memory also differ in their susceptibility to forgetting; information in episodic memory can become inaccessible rather easily, whereas this is not true for semantic memory. Traditional psychology experiments have studied the former primarily (for example, paired-associated learning, serial recall, free recall, recognition). The models that will be discussed in this paper will deal with the second one, i.e., *Semantic Memory*.

II. Network Models of Semantic Memory

II. a. General Characteristics

Network models depict LTM as a vast network of associated concepts. This is not unlike the stimulus-response (S-R) conception of memory: a bundle of associations. However, network models differ from S-R in the following:

(a) Most such models assume that different kinds of associations are formed, that not all associations are the same. When two concepts are associated, the relationship between the two is known; the association is more than a simple bond.

(b) Things that are close together conceptually may be expected to be closely associated in the LTM network. In this sense, LTM is like a dictionary, but its organization is not alphabetical, for example, apple and pear are close related because both of them have the same superordinate (fruit).

(c) The connections among concepts are circular; words are defined with other words.

(d) Current models of the structure of semantic LTM place primary emphasis on how it represents the kind of knowledge that is transmitted by language.

II. b. Quillian's Teachable Language Comprehender

The first model, we will see, in which language and associative networks play an

(2) E. Tulving, "Episodoc and Semantic Memory." In: E Tulving and W. Donaldson, *Organization of Memory* (New York: Academic Press, 1972), 381-403; H.L. Roediger & J.H. Nelly. "Retrieval Blocks in Episodic and Semantic Memory," *Canadian Journal of Psychology,* 36 (1982), 213-42.

important part is called the Teachable Language Comprehender (TLC)[3] This model is embodied in a computer program that attempts to simulate the ability of a person to comprehend and use language in a natural way.

What is the structure of LTM in this model? The format of factual information is made up of three types of structures: (1) *units*, (2) *properties* and (3) *pointers* (i.e. pathways being followed and represented by ------- >). Units and properties are places (or locations) in LTM that correspond to information about concepts, and they are more abstract than words. They are the LTM entries that correspond to words and not the words themselves.

A unit represents what is called "thingness" (for example, "car," "uncle," "mother," "Europe".[4] A property is a structure that tells about a unit. (In English grammar it would correspond to the predicate of a sentence, or an adjective, an adverb, and so on (for example, "graceful," "solid," "quickly," "likes hamburgers.")) Pointers are TLC's associations. They serve to associate dictionary labels with concepts in LTM, and they also associate units and properties inside the LTM network with one another. Definitions, then, correspond to patterns of associations between the dictionary labels and the qualities.

According to Collins and Quillian (1966), the nature of units and properties is described by a small set of rules: a *unit* consists of an ordered set of pointers; the first pointer of the unit must point to a second unit (its immediate superordinate). The remaining pointers of the unit point to properties; there can be any number of such properties. *Properties* consist of ordered lists of pointers, too. The first two pointers are required or obligatory. In general, a property can be thought of as some attribute plus a value of that attribute (for example, "its color is white"; color is the attribute, and white is the value).

As can be seen, the structure that evolves is a huge network of concepts. They are of two types, units and properties, and the pattern of interconnections serves to give them meaning. What ties them together are pointers or associations not traditional S-R but superordinate association, property association, attribute association and value association.

How is a sentence comprehended according to this model? This is accomplished by the *intersection search*. For example, when presented with a sentence such as "A

(3) M.R. Quillian, "The Teachable Language Comprehender: A Simulation Program and Theory of Language," *Communications of the Association for Computing Machinery,* 12 (1969), 459-76; A.M. Collins, and M.R. Quillian, "Retrieval Time from Semantic Memory," *Journal of Verbal Learning and Verbal Behavior,* 8 (1969), 240-47.

(4) Quillian, p. 462.

wolf can bite," the search process simultaneously enters LTM at the location of each concept named, then proceeds outward from those concepts along the pointers or paths leading from them. Each time a pointer leads the search to a new concept, the concept is given a mark to indicate that it has been passed in the search and from the concept it was reached. At some point, it is probable that a pathway being followed will lead to a concept that has already been marked. At that point, we have an intersection. Finding an intersection means that the same point (the intersection) has been reached from two concepts. If the relation between the concepts in LTM is compatible with the relation in the input sentence, it can be said that is comprehended.

Consider Collins and Quillian's (1969) model as represented by Fig. 1.

Notations: [ ] = Unit
( ) = Property
---- > Pointer

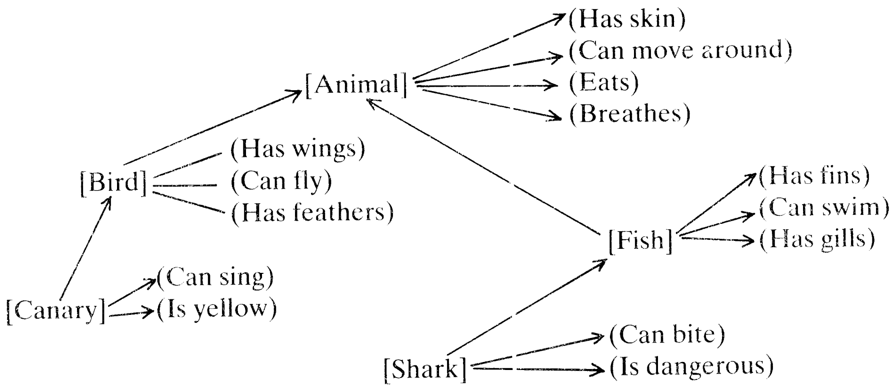

Fig. 1. Hypothetical Memory Structure for a Three-Level Hierarchy. (Collins & Quillian, "Retrieval Time," p. 241).

Collins and Quillian (1969) ran an experiment in order to test the TLC model. Suppose we have a memory network like the one depicted in Fig. 1; there exist two possible organizations of memory within it: (a) people may store with each bird type that flies (e.g., canary) the fact that it can fly, then they could retrieve this fact directly to decide if a sentence is true (for exampe, "the canary can fly"), (b) they may store only the generalization that *birds* can fly, and to infer that "a canary can fly" from the stored information in birds (and this could take longer to be decided).

There were two types of relations studied, property relations (P sentences), and superset relations (S sentences), and three levels: 0, 1 and 2. Some examples of these sentences are the following: PO, Baseball has innings; P1, Badminton has rules; S0 Chess is chess; S2 An elm is a plant.

They made some assumptions about procssing times: (a) retrieving a property from a node (or concept) and moving up a level in a hierarchy takes a person's time; (b) the times for these two processes are additive, whenever one step is dependent on completion of another step; and (c) the time to retrieve a property is independent of the level of the node, although different properties may take different times to be retrieved.

They stated two cautions, however; dictionary definitions are not very orderly and human memory may have the same characteristics (i.e. hierarchies are not always clearly ordered, as in dog, mammal and animal), and the other one is that people certainly store certain properties at more than one level in the hierarchy (for example, the more utilized properties).

In summary, properties are stored in an economical way (the so called "cognitive economy assumption"), that is, at the highest possible node. If one assumes that moving up and down in this portion of semantic memory takes time, verification times should increase the farther apart in the hierarchy the subject and predicate of the test sentences are.

The results of their study showed verification times to increase as a function of level. Traversing each node added about 75 milliseconds to the verification time. In addition, property sentences took longer than superset sentences, indicating that extra time was needed to retrieve a property from a noun node[5]

Problems of the model

(1) It takes longer to respond if a dog is a mammal than to say that it is an animal.[6]

(5) Collins and Quillian, pp. 240-42.

(6) E.E. Smith, E.J. Shoben, and L.J. Rips, "Structure and Process in Semantic Memory: A Featural Model for Semantic Decision," *Psychological Review*, 8 (1974), 214-41; E.J. Shoben, L.J. Rips, and E.E. Smith, *Issues in Semantic Memory: A Response to Glass Holyoak* (Tech. Rep. No. 101). Center for the Study of Reading, University of Illinois, 1978; Edward J. Shoben, "Theories of Semantic Memory," in Rand J. Spiro, ed. *Theoretical Issues in Reading Comprehension* (Hillsdale, N.J.: Erlbaum Associates, 1980).

(2) The cognitive economy assumption has been questioned by several authors.[7] Anderson and Bower[8] wrote that "there is no compelling reason to believe that human memory cannot retain any redundancy facts; there is not a strong need for erasure or garbage collection of redundant facts just to clean up the memory system." Wilkins showed that when category norms were used to determine the cojoint frequency of subject and predicate, reaction times were faster for the more frequent sentences.[9] Conrad[10] asked subjects to describe a canary, a bird, an animal and so on. She tabulated the frequency and found that the properties frequently associated with canary were the ones supposed by Collins and Quillian to be stored at the node *canary,* whereas the less frequent ones were stored in *bird* or *animal.* It could be that property frequency rather than hierarchical distance affects reaction time, and Conrad found exactly this.

II. c. Rumelhart, Lindsay and Norman's Model

Rumelhart, Lindsay and Norman[11] developed a model of a memory structure that has direct and explicit rules for translating external information into an internal representation, and that is flexible enough to support a variety of cognitive tasks (like problem solving, logical deductions, understanding a sentence, memorizing).

The nature of memory, in this model, can be conceptualized from two different aspects. The first concerns the structure of the *data base,* the way by which information is represented in the LTM. The second is the nature of the *processes* which operate upon the data base. One important aspect of the model is that processes are stored in the data base. They also propose that there is an *interpretative process* which operates on information contained within the data base, retrieving information when necessary and activating (or interpreting) the processes when that is necessary.

The basic structural element of the data base is a set of nodes interconnected by a relation R.

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(7) J.R. Anderson, and G.H. Bower, *Human Associative Memory* (Washington, D.C.: V.H. Winston, 1973). pp. 378-80; J.R. Anderson, *Language, Memory and Thought* (Hillsdale, M.J.: Erlbaum, 1976). J.R. Anderson, and L. Reader, "An Elaborative Processing Explanation of Depth of Processing," in L.S. Cermak and F.I.M. Craik, eds., *Levels of Processing in Human Memory* (Hillsdale, N.J.: Erlbaum, 1979).

(8) Anderson and Bower, p. 381.

(9) A. Wilkins, "Cojoint Frequency, Category Size and Categorization Time," *Journal of Verbal Learning and Verbal Behavior,* 10 (1971), 382-85.

(10) C. Conrad, "Cognitive Economy in Semantic Memory," *Journal of Experimental Psychology,* 92 (1972), 149-54.

(11) D.E. Rumelhart, P.H. Lindsay, and D.A. Norman, "A Process Model for Long-term Memory," in E. Tulving and W. Donaldson, eds., *Organization of Memory* (New York: Academic Press, 1972), pp. 197-246.

A *node* is a functional cluster of information that can represent a concept, an event or an episode in the system and may have any number of relations attached to it.

A *relation* is an association among sets of nodes and has two properties: it is labeled, and it is directed. Using the relation in the direction opposite to its label is equivalent to using the inverse relation. Relations, then, are bidirectional but not symmetrical. For example:

R
A ---- > B; R(a,b) = R – inverse (b,a).

If R specifies a superset relation, the R – inverse specifies a subset relation: Subset (a,b) = Superset (b,a).

The node is the only addressable unit in the memory system and encodes all of the ideas that make up the knowledge of the data base. They are of two types: *primary node:* which is the only node in the memory system that refers directly to the natural language words, and it may contain an abstracted definition of a given word expressed in the relational format, and *secondary nodes* which represent the concepts as they are used in specific contexts — a token use of a primary node.

There are three classes of information in the memory system according to this model: *Concepts, Events* and *Episodes.*

Concepts: Three types are very important: the classes to which the concept belongs, or *supersets* (they have an *is a* relation, like in "Luigi's is a tavern"), the *characteristics* which define it as a member of that class, (they have an *is* or *has* relation, like "Luigi's is noisy," or "Tavern has beer"), and the examples or *subsets* of that concept (they have the relation the *inverse of is a,* like in "Animal is a - inverse dog").

Events: An event is a scenario with actions, actors and objects. In general, a verb describes the action that is taking place, so the representation centers around the verb (This is conceptually similar to the ideas described in the *Case Grammar* by Fillmore.[12] The parts of an event, according to Lindsay and Norman are the following: action, agent, conditional, instrument, location, object, purpose, quality, recipient, time and truth.[13]

(12) C.J. Fillmore, "The Case for Case," in E. Bach and R.T. Harms, eds., *Universals in Linguistic Theory* (New York: Holt, 1968), 1-90; idem, "Types of Lexical Information," in F. Kiefer, ed., *Studies in Syntax and Semantics* (Dodrecht, Holland: Reidel, 1969), 109-137.

(13) P.H. Lindsay and D.A. Norman, *Human Information Processing,* (New York: Academic Press, 1972), p. 397.

Episodes: The representation of an event is centered around a single action. An episode is a cluster of events or actions.

Conceptual, event and episodic information is completely intermixed in the memory system, and all are represented in the same format. They are interpreted by the general interpretive system (or the executive program).

Beside the two major constituents of the memory system (relations and concepts), there are some minor constituents: operators and connectives.

A relation with a particular set of instances as its ranges is itself a concept, and is called a proposition. *Propositions* are those concepts which express facts among concepts. Propositions differ from other concepts in that they can be true or false, other concepts can only be said to correspond to an existent or nonexistent object.

The structure of memory that emerges is very similar to the one we have reviewed in the TLC model; that is, a huge network of nodes interconnected by relations and propositions.

However, this model can handle the process of pattern recognition by means of a *discrimination net.* Pattern recognition involves a series of binary tests constructed from an analysis of the properties of the input items. The tests are designed to uniquely classify each item within the context of the specific set to be discriminated, and the network evolves through the addition of new discrimination tests whenever an input item is incorrectly classified.

How does this model consider retrieval of information from the network? There are two possibilities: (a) Specify a pathfinding strategy for discovering and marking the links that interconnect nodes in the memory system, or (b) as a matter of reconstruction given some retrieval cues; rather than learn specific paths among the list items, the semantic characteristics of the items themselves are learned. Recall would be a matter of trying to find concept (nodes) in LTM that match up with these characteristics.

II. d. Kintsch's Model

This model is concerned with how information is stored in LTM, how sentences are understood and generated, and how inferences are made and also with texts and the meaning of texts.[14]

(14) W. Kintsch, "Notes in the Structure of Semantic Memory," in E. Tulving and W. Donaldson, eds., *Organization of Memory* (New York: Academic Press, 1972), 247-308; idem., *The Representation of Meaning in Memory* (Hillsdale, N.J.: Erlbaum, 1974).

One important part of this model is the *lexicon* (memory store that contains a person's knowledge about words).

How is the lexicon organized? It consists of three components: a matrix P of phonetic features which specify the sound of a word (and how this sound is to be produced), a matrix I of sensory features which represents sensory information associated with the dictionary entry (e.g., images), and a list S of syntactic-semantic markers which specify the use and meaning of the word. Only the semantic component of memory for words was reviewed by Kintsch (1972).

The lexical structures may be composed by: (a) feature systems(15) (b) systems based upon semantic relationships, or (c) less restricitive approaches employing logic-like languages.

He used the semantic relations as a base of the lexical structure in his model. Semantic relations are like associations, except that the nature of the relationship is specified. The characteristics of the semantic relations are the following: any word may be related to any other word, and a relationship is a complex expression, unlike a feature or marker. In order to define a word we must state what other word it is related to, and what the nature of the relationship is.

There are several types of semantic relations: synonymy (e.g., oddity-peculiarity), incompatibility (e.g., the set of color terms), antonymy (e.g., big-small), converse (e.g. buy-sell), consequence (e.g., fire-smoke).

Kintsch mentions two considerations about lexical components in memory: (1) economy of storage; the lexicon must be generative, not all the information about a word is directly stored in that word, the use of inferences is necessary, and (2) linguistic relevance.

Like the Rumelhart, Lindsay and Norman's model, this one holds certain resemblances with the *Case Grammar* of Fillmore,(16) and makes use of some of the most important case categories used by Fillmore: agent, instrument, experiencer, result, locative, and object.

A brief sketch of the components of the model is the following: A *text* is a sequence of connected sentences in a natural language. The meaning of a text is its *text base*. The text base consists of a sequence of propositions. *Propositions* in turn

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(15) J.J. Katz, and J.A. Fodor, "The Structure of a Semantic Theory," *Language*, 39 (1963), 170-210; idem. *The Modularity of Mind* (Cambridge, M.A.: MIT Press, 1983).

(16) Fillmore, "Cases," 36; Fillmore, "Types," 20.

are composed of *concepts.* Each proposition consists of one relational term and one or more arguments.

Example: Given the proposition "George hit John" in which there are three concepts, the relation HIT and the arguments GEORGE and JOHN, we have the following:[17]

(HIT, GEORGE, JOHN)

Concept definitions in semantic memory:
→ <HIT>: (HIT, agent, object, instrument)
→ <GEORGE>: . . . .
→ <JOHN>: . . . . (17)

Notational Notes: Concepts are written in capital letters to distinguish them from their corresponding words. A proposition is always enclosed in round brackets. The relational term is written first. And the concept in this proposition are defined in semantic memory.

How is a sentence comprehended according to this model? There are several ways to do it: (1) definitional sentences are accepted on the basis of a *pattern match;* a proposition identical with the sentence input is located in memory, (2) most sentences are accepted on the basis of *pattern completion,* and (3) there are sentences that are not "semantically acceptable," but that still can be given a metaphorical interpretation.

In these processes, there exist two kinds of *inference rules:* redundancy rules, which delete and regenerate redundant propositions, and lexical transformations rules, which are used to derive some words from more basic lexical entries.

III. Set Theoretic Models of Semantic Memory

Set theoretic models have treated memory as if it consists of sets of elements. The elements in the particular set may be all exemplars of that set (for example, one set may include all instances of dogs, whereas another set may include all instances of fruits).

(17) Fillmore, "Types," 24.

The elements in a set may include attributes of the concept represented by that set too (for example, one set may include all the attributes of Dog: it bites, barks, wags its tail, etc., and another, all the attributes of Fruits: is edible, is sweet, has seeds, etc.).

The model proposed by Meyer[18] was made using the following methodology:[19]

Stage 1	**Stage 2**	**Stage 3**
Cathode-ray tube indicates whether "all" or "some" is to be used on this trial.	Statement appears on cathode-ray tube.	S responds as quickly as possible.

All —— are ——   All S are P $\overset{RT}{\cdots\cdots>}$ "true" or "false"

Some —— are ——   Some S and P $\overset{RT}{\cdots\cdots>}$ "true" or "false"

The major outcome that Meyer found using this methodology is that statements using the word "some" (particular or existential affirmatives) led to faster responses (less reaction time (RT)) than statements using the word "all" (universal affirmatives). Why should this be the case?

In order to explain his obtained results, Meyer proposed a two-stage process. For statements using "all," the subject first retrieves the *set* of all categories that have some members in common, or intersect, with the P category (see the figure above). Then he decides whether every attribute of the P category is also an attribute of the S category. For example, Collie could be represented by a set of defining attributes of a collie, and Dog would be similary represented by a set of defining attributes of a dog. When E asks: "All collies are dogs," the subject first determines that the two categories do intersect and then determines that every attribute of dog is also an attribute of collie. For statements using "some," only Stage 1 is required (e.g., in "some females are professors," the subject only needs to decide that females intersect with professors, that is, only one example is needed).

Therefore, "some" statements require one stage to be executed, whereas "all" statements require two.

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(18) D.E. Meyer, "On the Representation and Retrieval of Stored Semantic Information," *Cognition Psychology,* (1970), pp. 242-300.

(19) Meyer, p. 287.

A set theoretic model like this can account for category size effects (true RT increases with category size[20] and false RT also increases with category size:[21] the larger P is, relative to S, the less they will overlap, and the longer it will take to find S in the Stage 1 search. For example, if S is "Canary" and P is "Bird," S and P overlap more than if P is "animal" (which is larger than bird).

Problems of the Model

(1) It cannot handle the Hadges analysis reported by Lakoff (1972): "Loosely speaking, a bat is a bird," means something like "A bat is a kind of like a bird, but is not really a bird." The problem is that there is no intersection between the categories "Bat" and "Bird" (that is, no bats are really birds).

(2) Meyer's Model does not explain the reversal of category-size effects when size is not consistent with relatedness.[22] For example, Why does Cat-Mammal take long to be verified than Cat-Animal?

VI. Features Models of Semantic Memory

Smith, Shoben and Rips[23] proposed a model of semantic processing, in which the semantic information is represented by only one means: *semantic features.* They considered a broader range of features than those which strictly define a concept (or category), and they proposed a two-stage comparison model in which the relationship between the two stages is probabilistic.

Assumptions of this model: the meaning of a word is not an unanalyzable unit but rather can be represented as a set of semantic features, and the features associated with a given category vary in the extent to which they define that category. In other words, they distinguish between *defining* and *characteristic features.*

The evidence for the latter comes from the Lakoff's concept of Hedges.[24] Smith et al.[25] said that in a sentence like "Robin is *a true* bird," the subject and the

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(20) Collins and Quillian, pp. 240-47; Meyer, pp. 287-89.

(21) T.K. Landauer, and J.L. Freedman. "Information-retrieval from Long-term Memory: Category Size and Recognition Time," *Journal of Verbal Learning and Verbal Behavior,* 7 (1968), 291-95.

(22) L.J. Rips, E.J. Shoben, and E.E. Smith. "Semantic Distance and the Verification of Semantic Relations." *Journal of Verbal Learning and Verbal Behavior,* 12 (1973), 1-20.

(23) Smith, Shoben and Rips, p. 217.

(24) G. Lakoff, "Hedges: A Study in Meaning Criteria and the Logic of Fuzzy Concepts," *Papers from the Eighth Regional Meeting, Chicago Linguistics Society* (Chicago: University of Chicago Linguistics Department, 1972).

(25) Smith et al., p. 217.

predicate nouns share the defining and the characteristic features; in a sentence such as "*Technically speaking,* a chicken is a bird," the subject and the predicate nouns share the defining, but not the characteristic features; and in a sentence like "*Loosely speaking,* a bat is a bird," the subject and the predicate nouns share the characteristic, but not the defining features.

A different source of experimental evidence for the distinction between defining and characteristic features comes from the typicality ratings in a multidimensional scaling of categories. Subjects are presented as a set of instance-category pairs (e.g., robin-bird), with several instances being used for each category, and are simply asked to rate how typical each instance is of its associated category.[26] The use of the term dimension here suggests a continuum of values.[27]

The two-stage model is the following:

(1) It consists of three processes: (a) lists of features for the instance and category are retrieved (defining and characteristic), (b) these two lists are compared, with respect to all features, yielding a measure X, of overall similarity, and (c) the resulting X is compared to two criteria levels of overall similarity, present before the start of the trial; a high level called C_1, and the other, a low level called C_0. If X exceeds C_1, then a positive response (true) can be made, while if X is less than C_0, a negative response (false) is executed.

(2) In this stage the person separates the more defining features from the characteristics on the basis of feature weights and compares the set of defining features of the category to those of the test instance. A positive response can be made if (a) each defining dimension of the category is also a defining dimension in the instance, and (b) the particular values (features) on these dimensions which the instance possesses are within the range of allowable values for the category.

Stage 1 of the model may be characterized as "*holistic,*" in that it considers all features, and as "*intuitive,*" in the sense that it considers only overall similarity of features rather than which features are similar. This stage is also *error prone,* in that for *true* items X may occasionally be less than C_0, resulting in an erroneous false response. On the other hand, stage 2 is considered to be *selective,* as it considers defining features, *logical* in that it bases its decision on a procedure that evaluates only defining features, and *relatively error free.*

(26) Rips et al., p. 17. E. Rosch, "On the Internal Structure of Perceptual and Semantic Categories," in T.E. Moore, ed., *Cognitive Development and Acquisition of Language* (New York: Academic Press, 1973).

(27) Smith et al., p. 240; Rosch, "Internal Structure," idem., Universals and Cultural Specifics in Human Categorization" in R. Breslin, W. Loner, and S. Bochner, eds., *Cross-cultural Perspectives* (London: Stage Press, 1974).

Smith et al. stated that this contrast between early holistic and later analytic processing accords well with their[28] own introspections that decisions about logical matters are sometimes made quickly on a basis of similarity, while at other times decisions are the result of a more deliberate process.

The authors of this model made the following predictions in a sentence verification task: (1) for any target category, true RT should decrease as the typicality[29] of the test instance increases, (2) correct false RT should decrease as relatedness (rather than typicality) decreases between the target category and the test instance, and (3) in those cases where increasing category size actually increases overall similarity, there should be a decrease in true RT, since the category size effects now facilitate both stages.

They found all these predictions tested in tasks like: "An S is a P" (e.g., "A chimpanzee is an animal").

Problems of the Model

(1) State 2 of processing is restricted to a comparison of a subset of the features sets in question, only if the defining features of the two concepts agree will a positive response occur; if the process shows that they are related only in incidental ways (e.g., "A cup is a coffee"), the sentence will be rejected as false. Kintsch (1974) has argued that this is too static a view of memory and that this stage is really one of inference making.[30]

(2) Lakoff's Hedges[31] cannot be meaningfully understood, unless category membership is considered to be a matter of degree rather than all or none. Rosch[32] has shown that natural categories, both perceptual (e.g., color) and conceptual, are defined only ambiguously by typical members, and that various degrees of category membership exist.

(3) The features that characterize (not define) a concept are always only potential features. Which features will be activated at any given time depends on *the context*. Therefore, which features are stored in memory will be equally context dependent.[33]

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(28) Smith et al., p. 240.
(29) Rosch, "Internal Structure."
(30) Kintsch.
(31) Lakoff.
(32) Rosch, "Internal Structure."
(33) C.F. Foard, and D.G. Kemler Nelson, "Holistic and Analytic Modes of Processing: The Multiple Determinants of Perceptual Analysis," *Journal of Experimental Psychology: General,* 113 (1984), =

(4) Semantic memory, thus, is not a clean, logical structure; but a rather messy one, with a great deal of flexibility.

Closing Remarks

The depiction of LTM as a set of locations connected by labeled associations is the fundamental characteristic of Network Models of LTM.

However, there exist some similarities among the Network, the Set of Theoretic, and the Semantic Features Models. All of them present a theory of meaning in which a concept (or node) derives its semantic content from its relation to others – whether by virtue of associations, by containing the other concepts as subsets in its definition, or by having those other concepts as features.

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11 94-111; T.B. Ward and E. Vela, "Classifying Color Materials: Children are Less Holistic than Adults," *Journal of Experimental Child Psychology,* 42 (1986), 273-302; T.B. Ward and J. Scott. "Analytic and Holistic Modes of Learning Family-resemblance Concepts," *Memory and Cognition,* 15 (1987), 42-54; D.G. Kemler Nelson, "When Category Learning is Holistic: A Reply to Ward and Scott," *Memory and Cognition,* 16 (1988), 79-84.

تقويم نماذج الذاكرة الدلالية طويلة الأجل

لطفي أحمد أبو الهيجاء

أستاذ مساعد، دائرة اللغة الإنجليزية وآدابها، كلية الآداب والعلوم الاجتماعية والإنسانية، جامعة *اليرموك، إربد، الأردن*

ملخص البحث: تمثل الصيغة الأساسية لأنماط الذاكرة الطويلة الأمد (LTM) مجموعة من المواقع المتصلة بترابطات مميزة. وتحكم أنماط الذاكرة الدلالية هذه صفات مشتركة فيما بينها، حيث تعرض كلها نظرية دلالية ذات مفهوم يستمد محتواه الدلالي من خلال علاقته مع مفاهيم أخرى. وبناء على ما تقدم، فإن الهدف الرئيس لهذا البحث هو تقديم هذه الأنماط وتقويمها.