

9.65 October 22, 2001 Memory V: Associative Memory HANDOUT

NOTE: that LAB 2 IS ON MONDAY NEXT WEEK. Also, pick up a copy of the Anderson reading for next time if you haven't already done so.

Assigned: Chap. 8.

Outline:

1. Meaning and Long-term Memory
2. Network Models of Semantic Memory
 - a. Quillian's network model of semantic memory
 - b. Spreading activation
 - c. Anderson's ACT
 - the fan effect and the paradox of the expert
3. Nodes, Links, and Connectionism

1. Meaning and Long-term Memory

To review: Much of memory seems to be structured associatively. In the next lecture on learning, you'll read about the conditions under which associative links are formed. Today, we focus on the way associations are **STRUCTURED**. It turns out that, in general, multiple links to already well-structured information gives the greatest chance of retaining the information. How do we know that?

Earlier in the course we discussed Craik and Lockhart's theory that Depth of Processing determines LTM. Another experiment, by Craik and Tulving (1975) on the effect of different tasks to be performed on a series of words.

-decide whether the test word would fit in a sentence, such as "He met a _____ on the street": FRIEND (versus TABLE)

-is this word in capital letters? friend

-does this word rhyme with WEIGHT? FRIEND

Differential later memory for the words. INTENTION to remember the words doesn't matter much.

SUMMING UP THE ROLE OF MEANINGFULNESS IN LT MEMORY: What gets linked up during encoding determines what gets remembered. And coding in terms of meaning provides the most distinctive encoding, the largest set of connections to already-known information, and therefore the most **RETRIEVAL ROUTES**.

Content-addressing, again.

Some kinds of information **CANNOT BE USED EFFECTIVELY** as a retrieval address, even though the information is in memory. E.g., word for a family relationship (for example, **grandmother, cousin**) that ends with **w**?

2. Network models of semantic memory

The idea that memory consists of associations between mental entities underlies **associative models** of human memory. In such models the contents of memory consist of mental representations of items and their associative connections.

a. Quillian's network model of semantic memory

Using the terminology of graph theory, items are commonly called **nodes** and connections between them are called **links**.

```
breathes
animal----has skin
reproduces
```

```
feathers
wings----bird
flies
```

```
swims
fish----scales
gills
```

```
predator          eagle          robin          eats worms          pink
Amer.symbol          red breast          salmon          edible
```

From Quillian (1966) and Collins & Quillian (1969).

has (or **hasa**) links (features or properties), **isa** links (superordinate, subordinate)

b. Spreading activation

Experiments by Collins and Quillian (1969)

Hierarchical structure

Economy of storage

Problems

c. Anderson's ACT:

Propositions, not just single concepts.

>From Anderson, 2000:

John bought some candy because he was hungry.

The fan effect

Paradox of the expert

Networks connecting concepts? E.g., Anderson, certain labelled links: **isa**

has

relation verbs/actions as relations between and **agent** and an **object**.

time and **location** make a proposition as episodic, rather than a semantic "fact" **Processing assumptions**

Needed: more complex accounts of the structure of information.

3. Nodes, Links, and Connectionism

Background: Perceptrons:

No way to represent "exclusive OR" (XOR):

Need **hidden units**

Connectionism or Parallel Distributed Processing (PDP)

Units and associative links (**connections**)

Distributed information

PDP framework:

1. Set of processing units
2. State of activation over these units
3. Pattern of connectivity among units
4. An activation function for each unit--either a threshold (fires or doesn't), or a smooth, continuous function such as a sigmoid.
5. Learning rule: modification by experience, by changes in weights that connect processing units, as a result of FEEDBACK (BACKPROP).
6. Environment of the system (e.g., where do the inputs come from, what sorts of outputs).

Many differences between the real CNS and the PDP models

The two most important advances of the PDP models are:

- (a) the demonstration that one can get "intelligent" performance out of simple units in a network just by adjusting the strength (weight) of the connection of one to another.
- (b) the very same units can participate in representing many different pieces of information.

Vital to this kind of model are HIDDEN UNITS.

Frequency