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SKKU ISS3147 Myths and Mysteries of Human Learning and Memory

Semantic Memory

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THINK ABOUT HOW MUCH "STUFF" YOU KNOW

What is the capital of Sweden?
What does an orange taste like?
What does the word *ambivalent* mean?
What does Barack Obama's voice sound like?
What are the ingredients of French Toast?
How many inches are there in a foot?
In what month is Labour Day?
Who is Roger Federer?
How late can you sleep and still make it to class on time?

Episodic / Semantic Memory Distinction

Tulving (1972) -- separate memory systems

Episodic memory

"stores information about temporally dated episodes or events, and temporal-spatial relations among these events"

Semantic memory

"It is a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations."

Episodic / Semantic Memory Distinction

Episodic memory

- Memory for specific events in context
- Conscious recollection (re-living the event)
- e.g., memory of eating an orange yesterday

Semantic memory

- General knowledge not linked to a specific learning experience/context
- e.g., what shape does an orange have?

If you wanted to find out how semantic memory was organised, how might you go about trying to solve the puzzle?

Methods for studying semantic memory

Association tasks

(Freud – personality)

Fruit – p

Fruit - ______

Sentence verification task

Can a canary sing? (measure RT)

The basis for most models of semantic memory

Category verification task

Bird-lion? NO

Bird-robin? YES (measure RT)

Lexical decision task

Present a word or nonword; subject has to decide as quickly as possible whether it is a real word or not. (measure RT)

Neuropsychological patients

Tip of the tongue (TOT) states

Neuroimaging

Models of Semantic Memory

Hierarchical model

(Collins & Quillian, 1969)

Feature Overlap Model

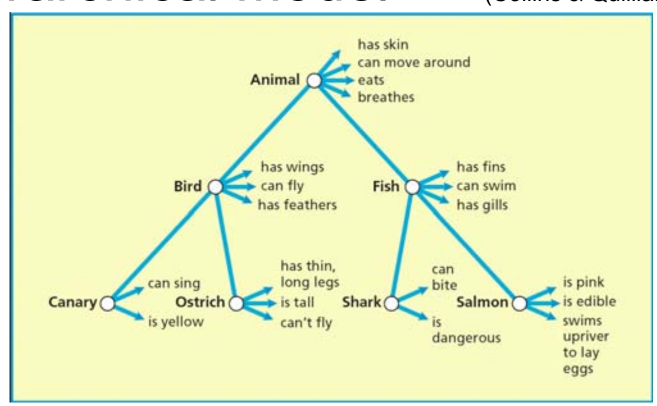
(Smith, Shoben, & Rips, 1974)

Spreading Activation Model

(Collins & Loftus, 1975)

Hierarchical Model

(Collins & Quillian, 1969)

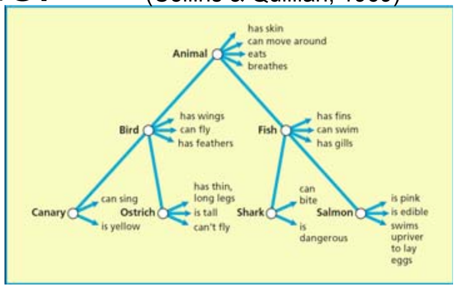


- Concepts arranged in a hierarchy (most general at the top, more specific instances below), with properties associated with each concept
- Principle of cognitive economy – each property listed as high up in the hierarchy as possible, to reduce redundancy

Hierarchical Model

(Collins & Quillian, 1969)

Assumptions of the model:
1. Retrieving a property and moving up/down the hierarchy takes time
2. Amount of time required is additive whenever one step is dependent on completion of another
3. Time required to retrieve a property is independent of the level of the hierarchy



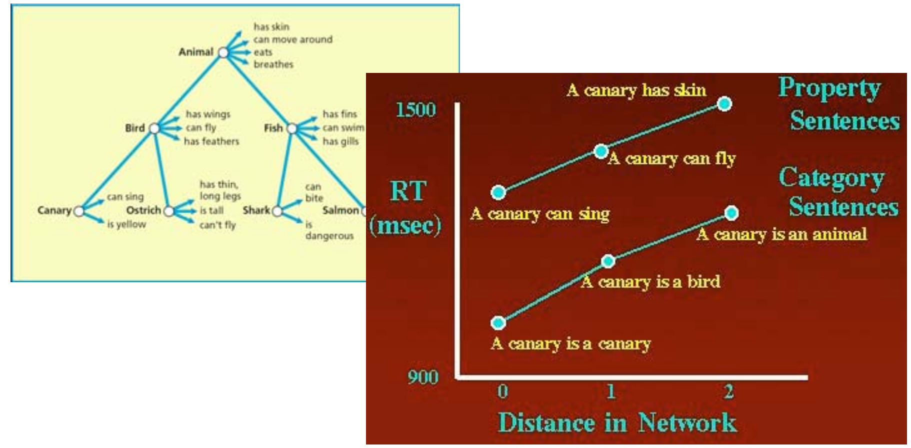
Prediction:

In a sentence verification task, more time will be needed as the number of levels between the tested concept and features increases.

'A canary can sing' should be faster than '*A canary can fly*', which in turn should be faster than '*A canary has skin*'.

Hierarchical Model

(Collins & Quillian, 1969)



Sentence verification RT results are mostly consistent with the predictions (for the "YES" responses).

Problems with the hierarchical model

1. Reversals of the category size effect
   A dog is a mammal (slower) vs. A dog is an animal (faster)
2. Typicality effects
   A robin is a bird (faster) vs. An ostrich is a bird (slower)
3. Challenges to cognitive economy
   A banjo has strings (distance 0) slower than An orange is edible (distance 2)
4. Doesn't predict fast RTs for implausible sentences

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Meaning of a concept determined by a set of features:

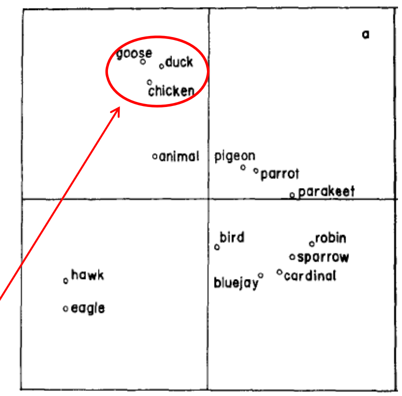
Defining features – essential

Characteristic features – typical

Bird	Robin
animate	animate
feathered	feathered
has a beak	.
.	.
.	red breast
.	eats worms

Evidence supporting idea that meaning of a concept is a set of features

Subjects rated how typical instances of various categories are. These typicality ratings can be represented in terms of distances in 2D-space.



Relatively far away from 'bird'… i.e., not typical birds

(Rips, Shoben, & Smith, 1973)

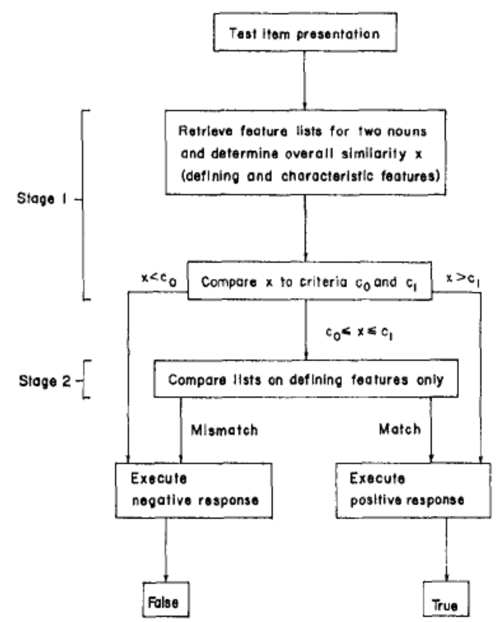
Evidence supporting idea that meaning of a concept is a set of features

For a particular category (e.g., *birds*), *subjects were* told that one of the species (e.g., *goose*) had an unknown contagious disease. They were asked to estimate the proportion of other species that would be infected. The results indicated that the typicality of the species influenced subjects' judgments.

	Estimated Percent Infection Rate					
Infected Species	*Goose*	*Duck*	*Robin*	*Sparrow*	*Hawk*	*Eagle*
Goose	–	**74**	17	18	16	13
Duck	**81**	–	18	18	43	35
Robin	26	30	–	**79**	35	41
Sparrow	32	27	**66**	–	49	43
Hawk	40	27	27	29	–	**63**
Eagle	17	16	26	29	**72**	–

(Rips, 1975)

Feature Overlap Model (Smith, Shoben, & Rips, 1974)



When making a comparison between 2 concepts:

1. The feature lists of both are retrieved and compared.
2. An overall measure of similarity or overlap is computed *(x)*.
3. If *x* exceeds an upper criterion, respond YES quickly. If *x* is lower than a lower criterion, respond NO quickly. (Stage 1)
4. If *x* falls between the 2 criteria, then a slower, more analytic comparison is made. (Stage 2)

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E.g.,

Is a robin a bird? (high overlap → fast YES)

Is a house a bird? (low overlap → fast NO)

Is a bat a bird? (intermediate overlap → a second process/stage kicks in, in which defining characteristics are carefully examined)

Feature Overlap Model (Smith, Shoben, & Rips, 1974)

Advantages:

1. Can account for typicality effects
2. Can account for quick NO responses (e.g., Is a house a bird?)
3. Can account for differences in speed of NO responses (e.g., Is magnesium an animal? vs. Is a tree an animal?)

One problem:

• Some concepts hard to define (e.g., can you name one feature that all games have in common?)

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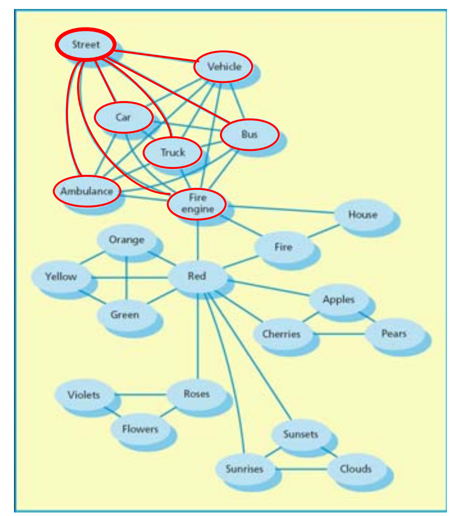
Spreading Activation Model (Collins & Loftus, 1975)

- Knowledge represented as a semantic network
- Related concepts are linked
- Length of link represents degree of association / relatedness
- The more common links 2 concepts have, the more similar they are
- When a concept is processed, activation spreads out along all paths / links
- Strength of activation decreases as # of paths increases
- Activation decreases quickly over time



Primary evidence for Spreading Activation Model

- Semantic (or associative) priming

  – Lexical decision task:

BESK	NURSE	NURSE	BREAD	BESK
MARB	DOCTOR	BUTTER	MARB	DOCTOR

If both items on the screen are real words, press ‘YES’; otherwise press ‘NO’.

(Meyer & Schvaneveldt, 1971)

Priming on a lexical decision task

Table 12.3 Mean response times.

Top String	*Bottom String*	*Example*	*Mean RT*	*% Errors*
Word	Associated word	nurse-doctor	855	6.3
Word	Unassociated word	nurse-butter	940	8.7
Word	Nonword	bread-marb	1087	27.6
Nonword	Word	besk-doctor	904	7.8
Nonword	Nonword	besk-marb	884	2.6

Source: Data from Meyer & Schvaneveldt (1971).

85 ms
priming

Neuropsychological studies of semantic memory

Aphasia – impairment in the use of language

e.g., nouns, specific categories, etc.

Agnosia – impairment in object perception

e.g., prosopagnosia (impaired face recognition)

Which of the following 2 pictures is associated with this one?

If a patient chooses the wrong object (the frying pan), is it because s/he has lost the concept of a racquet, or because s/he knows it’s a racquet but no longer understands its function?

Deficits in neuropsych patients can be hard to interpret, but they can offer significant clues and insights into how knowledge may be organised in the brain.

Neuropsychological studies of semantic memory

Some patients have a deficit with a specific category of words (e.g., colours, body parts, kitchen appliances, foods).

Warrington and Shallice (1984): 4 patients (w/ temporal lobe damage due to herpes encephalitis).

- Severely impaired in identifying/defining living objects. E.g.,
- “What is an ostrich?” JBY’s answer: “Unusual”
- “What is a wasp?” SBY’s answer: “Bird that flies”
- Relatively spared in identifying/defining non-living things.

Other patients have the opposite pattern of deficits (impaired in inanimate but not animate objects), although less common.

Why important? *A (double) dissociation.*

Neuropsychological studies of semantic memory

Can we conclude that concepts referring to living things are stored separately in the brain from concepts referring to manmade objects?

Not necessarily…

Visual/perceptual features are of greater importance in distinguishing living things, whereas function (what it does) is more important for distinguishing nonliving things.

Computer simulation model by Farah and McClelland (1991) supports this sensory/functional view.

Organisation of Semantic Memory in the Brain

Cree and McRae’s (2003) Multiple Feature Approach:

Deficit Pattern	Shared Properties
Multiple categories consisting of living creatures	Visual motion, visual parts, color
Multiple categories of nonliving things	Function, visual parts
Fruits and vegetables	Color, function, taste, smell
Fruits and vegetables with living creatures	Color
Fruits and vegetables with nonliving things	Function
Inanimate foods with living things	Function, taste, smell
Musical instruments with living things	Sound, color

Any category strongly relying on a damaged property will be impaired.

Metaknowledge

- “Tip of the tongue” states
- Feeling-of-knowing judgments

Tip-of-the-tongue state

A navigational instrument used in measuring angular distances, especially the altitude of sun, moon, and stars at sea.

Favouritism shown to a relative.

A group of witches.

"The signs of it were unmistakable; he would appear to be in mild torment, something like the brink of a sneeze, and if he found the word his relief was considerable."

- Brown and McNeill (1966)

Feeling-of-Knowing Judgments

What is the capital of Nepal?

What is the capital of North Dakota?

What is the capital of Nepal?

a. Islamabad
b. Kathmandu
c. Taipei
d. Dhaka

What is the capital of North Dakota?

a. Pierre
b. Helena
c. Cheyenne
d. Bismarck

Feeling-of-Knowing Judgments

RJR (Recall, Judgment, Recognition) Procedure

What is the capital of Nepal?

Recall: Say answer (or "can't recall")

Judgment: Feeling of Knowing (from 1 to 6)

- 1 = Definitely don't know
- 6 = Very sure you know the answer, even though you can't recall it at the moment

Recognition: 4 AFC

e.g., Islamabad, Kathmandu, Taipei, Dhaka

(Hart, 1965)

Feeling-of-Knowing Judgments

For items where subjects could not recall the correct answer:

FOK Rating	Proportion Correct on Recognition Test
6	.78
5	.57
4	.54
3	.48
2	.53
1	.30

….. Gradients of knowing.

(Hart, 1965)