Cognitive Psychology

PSYC230

Lecture # 11

How is information stored in the mind?

What is the "unit of thought"?

A word?
An image?
A logical proposition?

One of the oldest questions
in psychology

Knowledge Representation

What does memory research tell us?

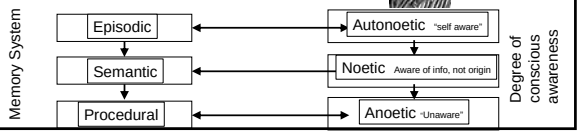
Different kinds of encoding processes
appear to produce different kinds of memories

Maintenance rehearsal
Distributed practice,
acoustic interference

Elaborative rehearsal
Meaningfulness &
depth of processing

Different patterns of forgetting suggest different types of memories

Tulving's (1985) model



Procedural Memory
frames & scripts

Knowing how: to ride a bicycle,
play the piano, sign your name, etc

Declarative Memory
Episodic **Semantic**

Knowing that: facts about your past (context-bound)
and facts about the world (context-free)

Procedural Knowledge

usually skilled motor sequences

How to: ride a bicycle, play the piano, sign your name, etc
Stored as scripts (procedures) and frames

Formed as a result of process of proceduralisation
the shift from slow, explicit information about
procedures to rapid, implicit implementation
of open-loop procedures

We have lots of automatic scripts & procedures
we learn them very young

bedtime script, school script, doctor's office script
shower procedure, bicycle procedure, etc.

Procedural Knowledge

Requires no processing resources
or awareness to access information

an implicit, automatic memory process

Subject to various action slips
e.g., *Putting the coffee grinder in the fridge*

May be a separate memory system,
amnesiacs with declarative memory deficits
often have no deficits in procedural memory

Declarative Knowledge
"Knowing that"

Declarative knowledge can be acquired *tacitly*
(e.g., learning word meanings and grammar)

or *overtly (*e.g., times tables)

We are explicitly aware of
two types of information

Episodic: Personally experienced events

Semantic: World knowledge, language, & concepts

Episodic Memories

Autobiographical Memories

personally experienced events

Contextually-bound information
arranged in a hierarchy

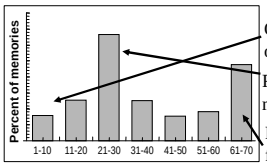
Lifetime periods
major ongoing situations, living with someone, a particular job, etc

General events
repeated or extended events, birthdays, vacations

Specific events
images, feelings, details from events lasting seconds to hours

Episodic Memories

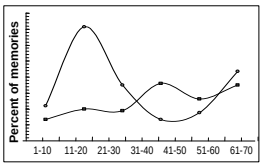
personal memories of people, places, & events organised by context



Childhood amnesia -- almost total lack of memories from the first 5 years of life

Reminiscence bump -- a large number of memories from the years between 15 & 25

Retention function -- memories from recent past, recently exercised



Schrauf & Rubin (1998)

The effects of age of emigration on the reminiscence bump

- emigrated ages 20 - 24
- emigrated ages 34 - 35

Cognitive Change Hypothesis – periods of rapid change followed by stability lead to better encoding

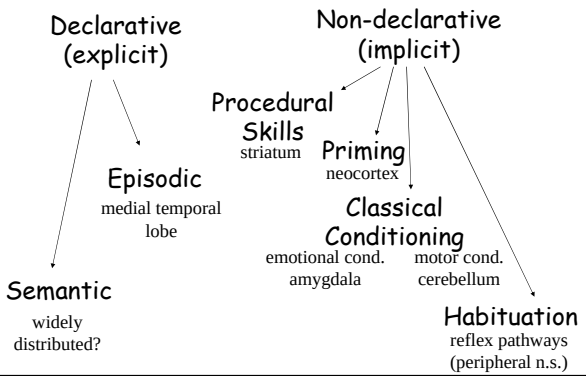
Semantic Memory

world knowledge, language, & concepts

Organised in terms of meanings & relationships -- not dependent on context

Hippocampus appears to gradually consolidate new information with established cortical/structural memories, results in permanent, generalised memories

Taxonomy & Anatomy of Memory



Is memory the same as knowledge?

Some information isn't stored in memory at all,
but we can still answer correctly

We use **knowledge** to compute

information that we do not have stored

The relationship between stored facts (memories) is every bit as important as the facts themselves

Semantic Memory / Knowledge
(world facts)

Network of "fact nodes" interrelated by logical connections

Information exercised in so many different places & times it has become context free

Semantic Memory / Knowledge
world knowledge, language, & concepts

Organised in terms of meanings & relationships -- not dependent on context

Theories of Semantic Memory Representation

Hierarchical Network Theory
(semantic network model)

Prototype Theory

Exemplar Theory

Feature Comparison Theory

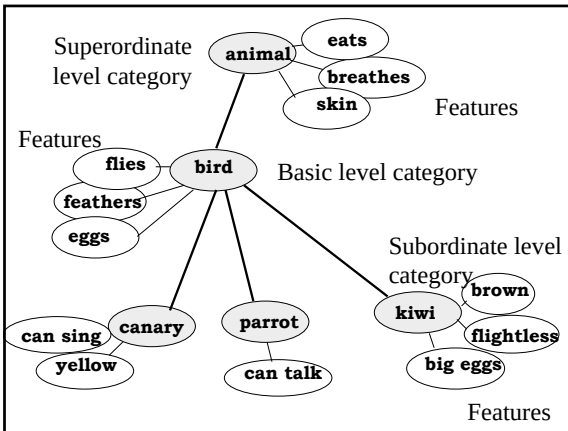
Hierarchical Network Theory
Collins & Quillian (1969)

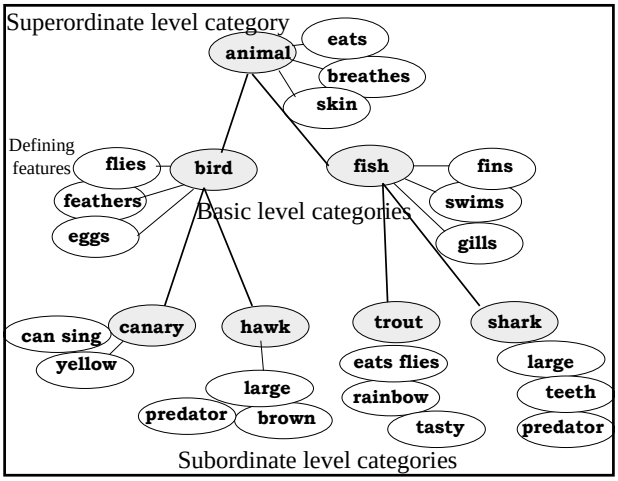
Knowledge in semantic memory is stored as a network of nodes interrelated via propositional (logical) connections

Category: a group of objects or events (like a schema)

Individual instances are called *exemplars*

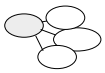
Each category has a set of necessary and sufficient conditions for membership
Defining features



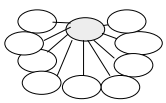


Basic level categories are psychologically "privileged"

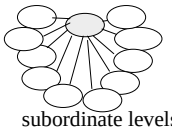
(Rosch & Mervis, 1975)



superordinate levels have an average of 3 attributes



basic levels have an average of 9 attributes



subordinate levels have an average of 10.3 attributes

moving up a level in the hierarchy
loses a lot of information
moving down a level gains only a little

How is knowledge organised in a hierarchical network?

Principles of
Property Inheritance

Concepts "inherit" the properties of "parent" concepts in the hierarchy

Cognitive Economy

Information is stored once, at the highest possible node in the hierarchy (saves space)

e.g., Properties true of all animals *(have skin, breathe, eat, move)* are stored at animal node rather than with specific type of animal

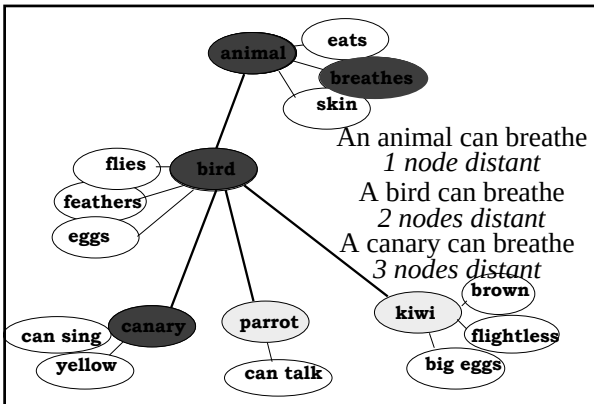
How is information accessed in a hierarchical network?

Intersection search

traversing the hierarchy (up and down) takes time to move between levels

Cognitive economy and intersection search principles predict the Category-Size Effect

A canary can breathe
takes longer to verify than
A bird can breathe
which takes longer than
An animal can breathe



An animal can breathe
1 node distant
A bird can breathe
2 nodes distant
A canary can breathe
3 nodes distant

Category Size Effect

But…

The Typicality Effect

typical members of the category are responded to more rapidly than atypical members
(Smith et al, 1974)

"An ostrich is a bird"
takes longer to verify than
"A canary is a bird"

According to the hierarchical model, this shouldn't happen because ostriches and canaries are at the same level
(one node away from bird)

But wait, there's more…

A pig is an animal
is verified more rapidly than
A pig is a mammal

The Category-size effect is affected by the frequency with which a property is paired with a concept

A bird has feathers
is verified more rapidly than
A bird has toenails

because feathers are more frequently associated with birds than are toenails

But wait, there's even more…

Some properties may be stored at multiple levels (no cognitive economy)
(Conrad, 1972)

Free association task *"Write down as many things about canaries that come to mind"*

Canaries are yellow
Canaries have feathers
Canaries sing
Canaries can fly
Canaries lay eggs

Bird-level properties sometimes get named before canary-level properties

Later developments: Semantic Network Model

(Collins & Loftus, 1975)

Dropped hierarchical structure
No strict cognitive economy
(some redundant information allowed)

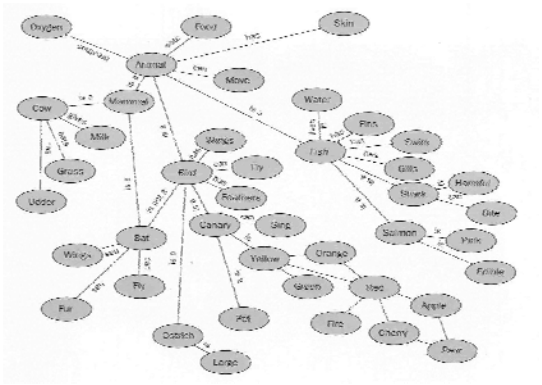
Typical members stored more closely to the category name or prototype member

Properties more important are stored more closely

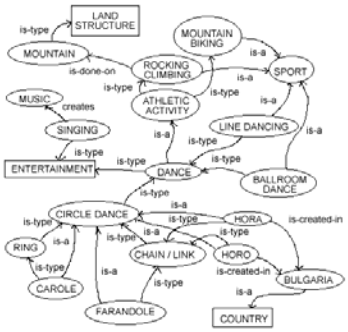
Network searched via Spreading Activation

Semantic Network Model

(Collins & Loftus, 1975)



Semantic Network Model for the circle dance

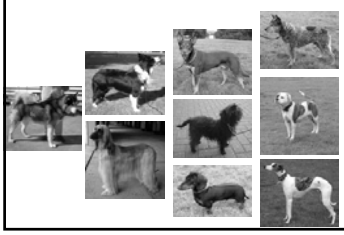


Semantic Network Model for "sports"

Alternative approaches
Prototype Theory

prototypes are what is stored at each level in the semantic network

a prototype is the representation of the average instance of the category



prototype "dog"

Prototype Theory

Category membership is determined by "***family resemblance***" based on characteristic features
(Rosch & Mervis, 1975)

Compare instances to a "prototype" that best represents the members of that category (prototype formed through abstraction)

Decision times are determined by similarity to prototype

Focus on Characteristic Features instead of Defining Features

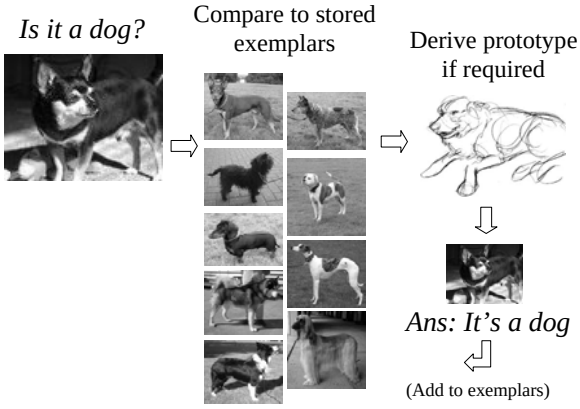
Exemplar Theory

Instead of comparing to a single prototype we compare to multiple exemplars
(Estes, 1994; Ross & Spalding, 1994)

Decision times are still determined by similarity to *characteristic features*

but abstraction occurs *during retrieval* instead of encoding

Exemplar Theory



Feature Comparison Theory

(Smith, Shoben, & Rips, 1974)

Knowledge is stored as a set of feature lists:

defining features
(necessary for membership--e.g., "feathers" for birds)

characteristic features
(typical, but not necessary--e.g., "sing" for birds)

Feature Comparison Theory

Two-stage comparison process

Stage One

Compare instance and category on all features (characteristic and defining)

If high degree of overlap, respond "true"

If low degree of overlap, respond "false"

Stage Two

If moderate degree of overlap, proceed to second stage and check defining features only

Feature Comparison Theory

Two-stage comparison process

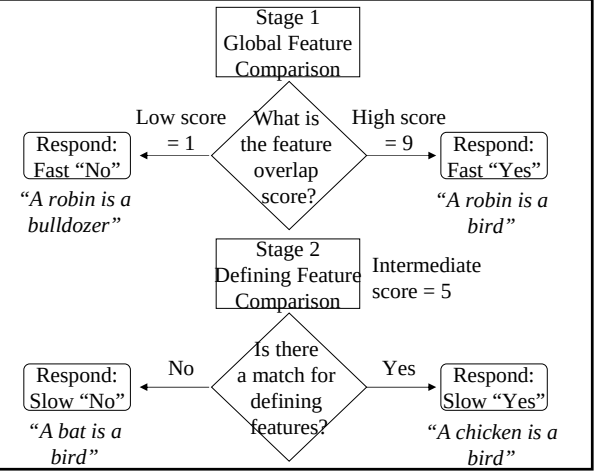
Fast decisions with high degree of overlap

A canary is a bird
Canary matches both defining and characteristic features of bird

Second stage required with moderate overlap

An ostrich is a bird

Ostriches have few characteristic features but do fit defining features of a bird



Feature Comparison Theory

Predicts Typicality Effects

positive and negative

e.g., *A whale is a fish*
takes longer than
A horse is a fish

Whale shares characteristic features with *fish* therefore leading to high degree of overlap and long "*No*" response times

But…

How are "*features*" determined?

e.g., what are the features of a "game"? (Wittgenstein's famous argument)

Compare soccer, poker, hopscotch, "I spy", solitaire, cat's cradle….

Prototype & Exemplar Theories also both account for Typicality Effects but Exemplar Theory is a better match to human performance

The relationship between stored facts (memories) is every bit as important as the facts themselves

Organisation matters !!!

This week's laboratories
finish the experiment on

Organisation as an aid to memory

Remember: Quiz in labs next week!

Questions?