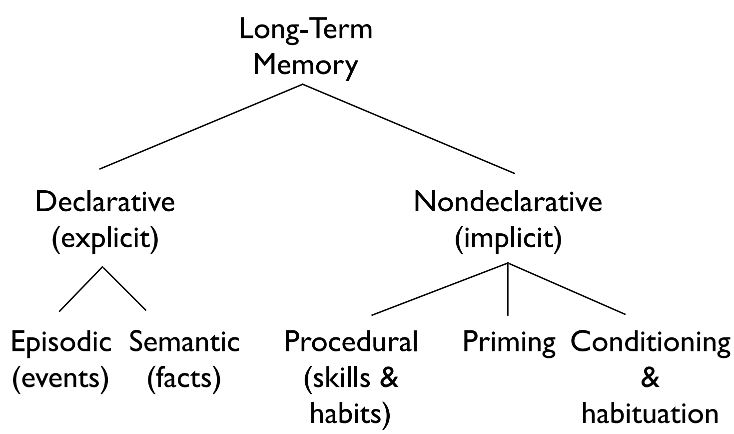
Chapter 7

Knowing
Semantic Long Term Memory

Review / Background

- LTM Taxonomy / Episodic LTM
- Learning (Storing information in LTM)
  - rehearsal, depth, self-reference, generation & enactment, organization, imagery, context
- Remembering (Retrieving information from LTM)
  - availability vs. accessibility
- Clinical Evidence
  - Amnesia and Implicit Memory

Squire (1993) Taxonomy of Long-Term Memory



Chapter Outline

- Semantic Memory
  - Network Model, Feature Comparison Model, Revised Network Model
- Connectionism
- Semantic Priming
- Schemata & Scripts
- Concepts & Categorization

Semantic Memory

Terminology

- Semantic Long Term Memory
- aka
  - Factual memory
  - “generic” memory
  - conceptual knowledge
  - memory for “meaning”

Models of Semantic Memory

- Semantic Network Model…
- Feature Comparison Model…
- Revised Network Model…

Semantic Network Model

- Collins & Quillian (1969)
- **Network**
  - interrelated set of concepts
- **Nodes**
  - part of the network representing one concept
- **Pathways**
  - labeled directional pathway associating two concepts
- **Propositions**
  - Represents a relationship between concepts
- **Function**
  - Spreading Activation

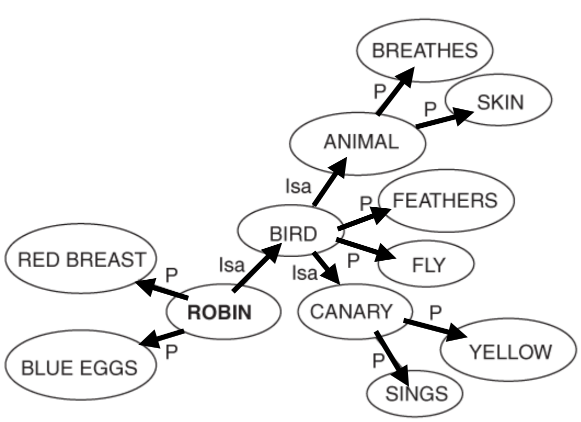
Propositions

- Express a relationship between concepts
- Examples
  - A robin has wings
  - An apple is a fruit

Pathways and Propositions

- Pathways connect two nodes together to form propositions.
- **ISA** pathways express category membership (e.g., A robin is a bird).
- Property (**P**) pathways express properties that concepts possess (e.g., x has the property of y-- a **robin** has the property of **wings**).

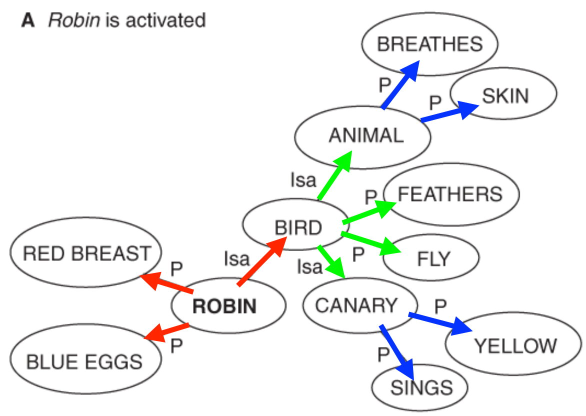
Semantic Network Example



Spreading Activation

- The mental activity of accessing and retrieving information from the network.
- Takes passive concepts (those not currently in working memory) and activates them (puts them in working memory).
- Activation then spreads to related nodes (e.g., activation to the **doctor** node would also spread to the **nurse** node).
- This is one explanation for **Semantic Priming**

Spreading Activation



Intersection Search

- True or False:
  - **A robin is a bird?**
- Activation lights the **robin** node, and then spreads to its neighbors.
- Activation also lights the **bird** node, and then spreads to its neighbors.
- The two spreads of activation eventually collide-- an intersection-- which lets you answer "True, a **robin** is a **bird**."

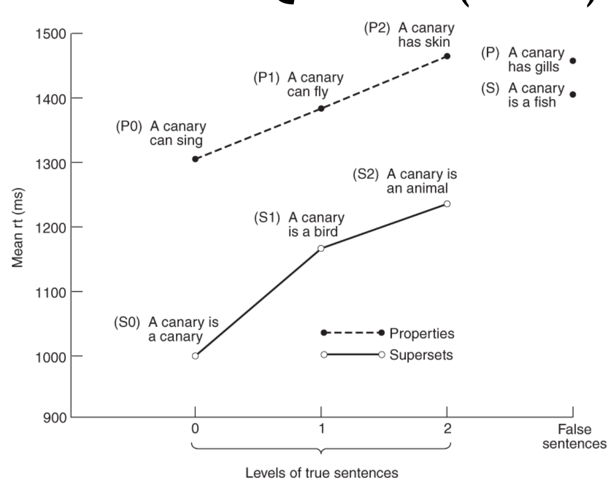
Semantic Relatedness

- The **distance** between two nodes in a network is determined by semantic relatedness.
- Concepts close in meaning / highly related (e.g., doctor, nurse) are stored close together in memory (few steps)
- Unrelated concepts (doctor, truck) are further away (more steps through more nodes)

Support for the model

- Stimuli
  - semantic statements
    - "A canary is an animal"
- Methods
  - recognition task
  - simple yes/no answer
- DV
  - Reaction Time
- IV
  - level of semantic relatedness (level 0, 1, 2)

Collins & Quillian (1969)



Problems with the model: Typicality Effect

- Typicality effect
- RT Prediction?
  - "A pig is a mammal"
    vs
  - "A pig is an animal"
- CQ's model prediction is opposite of observed data

Problems with Semantic Network Model

- **Cognitive Economy**
  - assumes information only appears once in the model
  - logical, but unrealistic
- **Developmental Issues**
  - **Dolphin** is a **Fish**?
    No
    Dolphin is a **Mammal**
  - Would require big reorganization

Feature Comparison Model

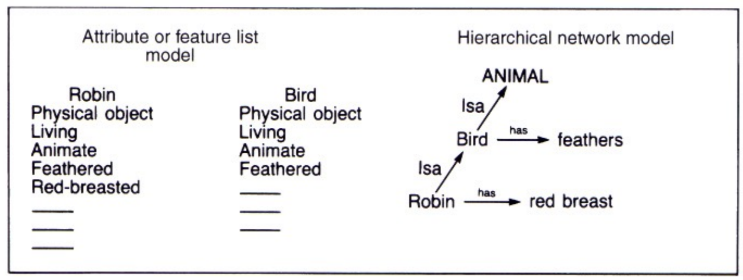
- Smith et al. (1974)
- Attempted to fix some of the problems with Collins & Qullian model

- Semantic Memory is List-based
  - **Feature List…**
  - **Defining Feature**
  - **Characteristic Feature**

Feature Lists

- **Defining Features** at top of list
  - essential features
  - e.g. Robin is a…
    Physical Object
    Living
- **Characteristic Features**
  - common features that are not essential
  - e.g. Robin
    sits in a tree
    is pretty…

Feature List vs. Network Model



Feature Lists: Robin vs Bird

Robin	**Bird**
Physical Object	Physical Object
Living	Living
Animate	Animate
Feathers	Feathers
Flies	Flies
Red-breasted	

Feature Lists: Telephone vs Bird

Telephone	**Bird**
Physical Object	Physical Object
Not Living	Living
Inanimate	Animate
Plastic	Feathers

Feature Comparison

- **T/F:** A Robin is a Bird?
- Access both Feature Lists
- Compare lists (feature overlap)

- Stage 1 (Fast)
  - if overlap score is very high (or very low) give a quick Y/N answer
- Stage 2 (Slow)
  - if overlap score is indeterminate,
  - compare **Defining Features**

Fast Yes: Robin vs Bird

Robin	**Bird**
Physical Object	Physical Object
Living	Living
Animate	Animate
Feathers	Feathers
Flies	Flies
Red-breasted	

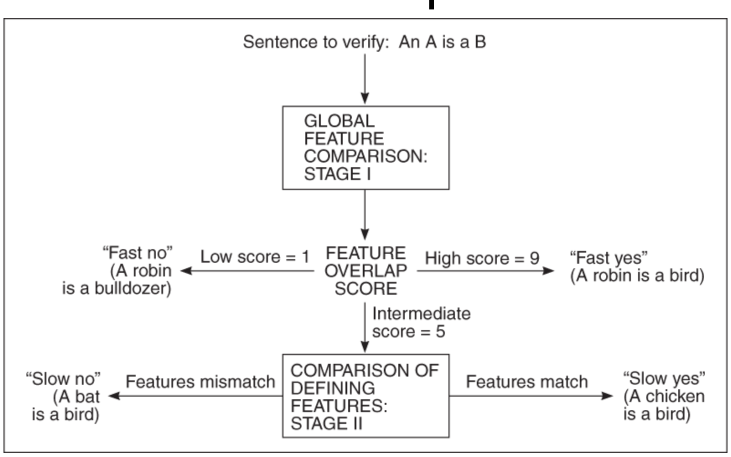
Fast No: Telephone vs Bird

Telephone	**Bird**
Physical Object	Physical Object
Not Living	Living
Inanimate	Animate
Plastic	Feathers

Slow No: Bat is a Bird?

Bat	**Bird**
Physical Object	Physical Object
Living	Living
Animate	Animate
No Feathers	Feathers
Flies	Flies
Live Births	Lays Eggs

Feature Comparison



Problems with Feature Models

- **Property Statements**
  - A Frog is **Green**
  - A Whale is **Large**

- Does your brain really have a list of "things which are **large**?

Problems with Feature Models

- **Lack of Hierarchy**
  - Arnold Schwarzenegger has Feet?
- Does your brain really store this fact for each person you know?
- Unlikely - probably the brain does use hierarchy.
- (Arnold is a man, men are people, people are humans, humans have feet)

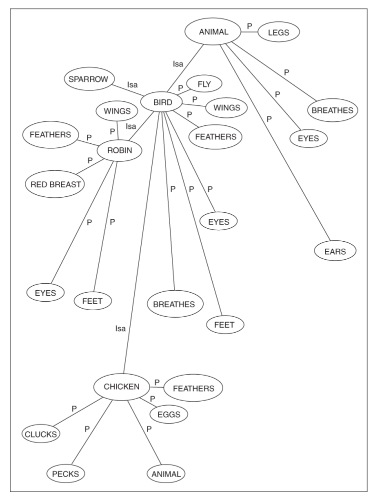
Improving the models

- Network Model (Collins & Quillian)
  - Couldn't handle Typicality Effect
- Feature Comparison (Smith)
  - was created to handle Typicality Effect
- Semantic Relatedness (Collins & Loftus, 1975)
  - an improved network model that can explain the Typicality Effect

Revised Network Model

- Collins & Loftus (1975)
- Similar to Network Model
- Adds **Semantic Relatedness**
  - links are different **strengths** (drawn as different **lengths**)
- Does not require pure hierarchy (Cognitive Economy): Redundant info can be stored

Revised Network Model



Semantic Relatedness Effect

- Concepts that are more highly interrelated are retrieved faster
- Revised Network Model:
  - Typical members are stored closer to category
  - Robin->Bird
vs
Chicken————————————->Bird

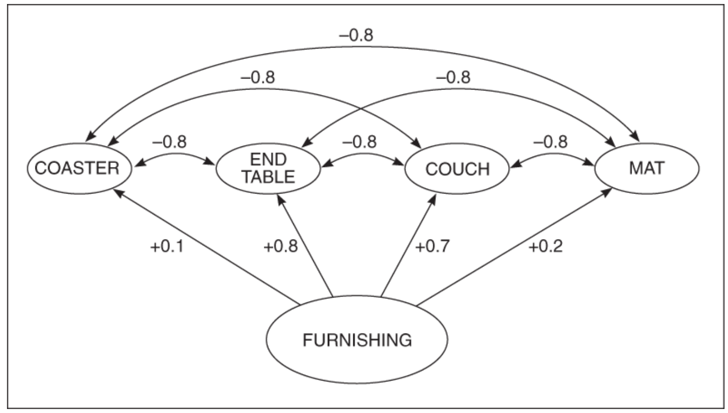
Connectionism and Semantic Memory

Terminology

- Connectionism
- PDP (parallel distributed processing)
- neural network

- Similar to Revised Network Model
- Differences:
  - paths (connections) are weighted
  - paths may be inhibitory (negative weights)
  - a "concept" is a pattern of activation across the network

Semantic Net Model



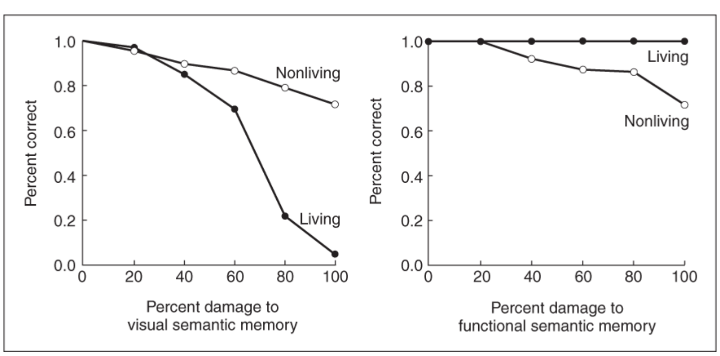
Connectionist Models

- Biological realism
  - nodes are like neurons, pathways like axons & dendrites
  - weights are like neurotransmitters (excitatory, inhibitory)

Connectionist Models of Semantic Memory Impairment

- Patient JBR - tested on naming objects
  - living things: 6%
  - inanimate objects: 90%
- How could this be?
- Theory:
  - living things classified by visual features
  - non-living things classified by function
- Model:
  - built a PDP model and then "lesion" it

Connectionist Models of Semantic Memory Impairment



Semantic Priming

Terminology: Priming

- Prime: the initial stimuli (believed to have an effect on the target)
- Target: later stimuli to be processed
- Priming
  - Facilitation - prime helps target processing
  - Inhibition - prime hurts target processing

- DV:
  - RT or accuracy
- IV:
  - kinds of relationship between Prime and Target

Lexical Decision Task

- Meyer and Schvaneveldt (1971).
- **Task**: Judge whether a string of letters is a word
- **Measures**: Reaction time
- **Manipulations**: Subjects were shown two words at once (related or unrelated)
  TRUCK PAPER (Unrelated YES)
  CHAIR ZOOPLE (NO)
  FIST HAND (Related YES)
- **Results**: Related words strongly primed each other, suggests looking up words meanings happens automatically when we look up its lexical information

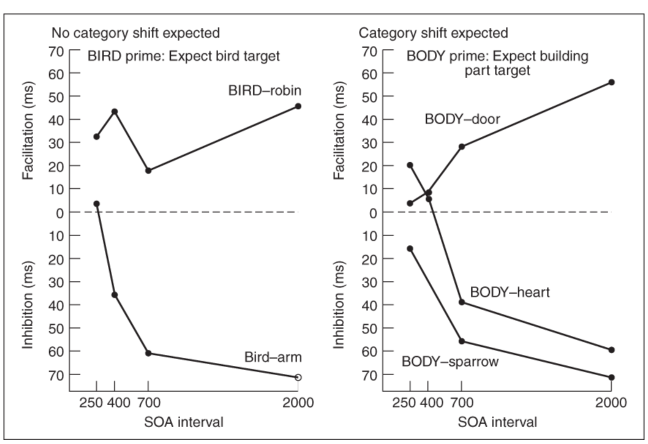
Lexical Decision Task: Results

Stimuli Pair	Y/N	Sample	RT	Accuracy
Word-Related Word	Y	Nurse-Doctor	**855**	6%
Word-Unrelated Word	Y	Bread-Doctor	**940**	9%
Word-Nonword	N	Book-Marb	1087	28%
Nonword-Word	N	Valt-Butter	904	8%
Nonword-Nonword	N	Cabe-Manty	884	3%

Automatic vs. Conscious Priming

- Neely (1977)
- Tested explicit vs. implicit priming
- Method:
  - S's told to expect category switch
    e.g. building —> body
  - tricked subjects (by not switching category)
  - varied the timing
- Results - evidence for
  - Automatic priming (at short delays)
  - Conscious priming (at longer delays)

Neely (1977)



Priming is Implicit

- Marcel (1980)
- Lexical decision task. Prime word was followed by mask, then by target word.
- Subjects were also tested on recognition for prime word.
- In spite of no conscious recollection for prime word, the target word was primed

Schemata and Scripts

Bartlett's (1932) "War of the Ghosts"

- Ebbinghaus: nonsense syllables
- Bartlett: meaningful information
- Methods:
  - S's read a folk tale
  - re-told the story
- Measures:
  - progressive changes in what subjects remember

One night two young men from Egulac went down to the river to hunt seals and while they were there it became foggy and calm. Then they heard war-cries, and they thought: "Maybe this is a war-party". They escaped to the shore, and hid behind a log. Now canoes came up, and they heard the noise of paddles, and saw one canoe coming up to them. There were five men in the canoe, and they said: "What do you think? We wish to take you along. We are going up the river to make war on the people." One of the young men said,"I have no arrows." "Arrows are in the canoe," they said. "I will not go along. I might be killed. My relatives do not know where I have gone. But you," he said, turning to the other, "may go with them." So one of the young men went, but the other returned home.

And the warriors went on up the river to a town on the other side of Kalama. The people came down to the water and they began to fight, and many were killed. But presently the young man heard one of the warriors say, "Quick, let us go home: that Indian has been hit." Now he thought: "Oh, they are ghosts." He did not feel sick, but they said he had been shot. So the canoes went back to Egulac and the young man went ashore to his house and made a fire. And he told everybody and said: "Behold I accompanied the ghosts, and we went to fight. Many of our fellows were killed, and many of those who attacked us were killed. They said I was hit, and I did not feel sick." He told it all, and then he became quiet. When the sun rose he fell down. Something black came out of his mouth. His face became contorted. The people jumped up and cried. He was dead.

Bartlett's (1932) "War of the Ghosts"

- **Omissions**:
  - Poor recall for many of the details (specific names, or events)
  - Minor events were omitted (but recall for plot and sequence of events was good)
  - Shorter than the original
- **Normalizations**:
  - Tendency to add and alter the stories to make them more conventional or reasonable (top-down processing)

Schemata

- Schema (plural: schemata)
  - Stored framework or body of knowledge about some topic.
  - Bartlett used this concept to explain subject alterations when re-telling the War of the Ghosts story.
  - When we encounter new material, we try to relate it into existing schemas (sometimes even altering the material to make it fit).

Reproductive vs Reconstructive Memory

- Reproductive memory:
  - A highly accurate, verbatim recording of an event.
- Reconstructive Memory:
  - Remembering by combining elements of experience with existing knowledge.
- Is all memory reconstructive?

Reconstructive Effects

- Sulin and Dooling (1974).
- Subjects read identical stories about either:
  Gerald Martin or Adolf Hitler.
  Carol Harris or Helen Keller.
- The Hitler and Keller groups' "memory" of these stories was influenced by their previous knowledge of Hitler or Keller.

Reconstructive Effects Take Time

- Immediate recall – memory is reproductive
- Delayed recall (1 week) – memory is reconstructive

Scripts

- Scripts is a subtype of Schemas
- General knowledge structures about ordinary events and situations that guide our interpretation and behavior
- Mental representation of what is supposed to happen in a particular situation in which order
- Examples:
  Birthday, restaurant, airport…
- Similar because of shared cultural knowledge

Script Example

- John was feeling very hungry as he entered the restaurant. He settled himself at a table and noticed that the waiter was nearby. Suddenly, however, he realized that he'd forgotten his reading glasses.

- What is John's problem?

Scripts and Memory

- Greaser 1981
- S's given stories to remember including typical vs. atypical events

- Memory for typical events: poor
- Memory for atypical events: good

- "Jack led the dog into the waiting room. While waiting for the vet, Jack dropped his car keys."

Review

- Semantic Priming
  - Automatic at short intervals
  - Explicit (under conscious control) at longer intervals
- Schemata
  - Reproductive vs. Reconstructive Memory
  - War of the Ghosts
    - Omissions
    - Normalizations
- Scripts
  - memory for typical vs. atypical events

Concepts & Categorization

- Major Theories
  - Classic
  - Probabilistic
  - Explanation-based

Classic View of Categorization

- Categories are based on system of rules
- Necessary and Sufficient features
- Scientific Taxonomy

- Logical, but probably not psychologically realistic

Natural Categorization

- What do categories look like when studying real people?

- Loose / Fuzzy
- Graded Membership

- Examples:
  - bat is not a bird, but loosely speaking it is
  - tomato is technically a fruit, but considered a vegetable
  - **4** is a better example of an even number than **28** (Armstrong et al 1983)

Natural Categorization

- Central Tendency
  - "average" or best examples
- Typicality
  - how close something is to Center
- Category Norms
  - robin is a better bird than chicken
- Family Resemblance
  - not all features are required, but many are
- Correlated Attributes
  - e.g. things with Wings have Beaks

Probabilistic Categorization

- Probability - statistical likelihood
- Prototype theory
  - a single example
  - typical or stereotypical example
  - the "core" or "central" example
  - does not include variation
- Exemplar Theory
  - we store examples of what we have seen
  - do not store a prototype

Probabilistic Categorization

- Prototype Theory vs Exemplar Theory:
- Which is true?
- Difficult to test - both make very similar predictions.
- Both theories do a good job of explaining human categorization
- But can't explain:
  - ad-hoc categories (new categories created on the fly)
  - circularity? How to form a category without already knowing the category?

Explanation-Based Categorization

- Semantic Categories are theories of how the world works
- Things to keep your feet safe:
  - Shoe & Sock? Yes
  - Brick? No
- Things to pound a nail:
  - Shoe & Brick? Yes
  - Sock: No

Embodied Categorization

- Categories relate to how our bodies & minds function the world
- Borghi et al. (2004)
- You are diving a car (inside)
  vs.
  You are washing a car (outside)
- RT to objects faster when consistent with location

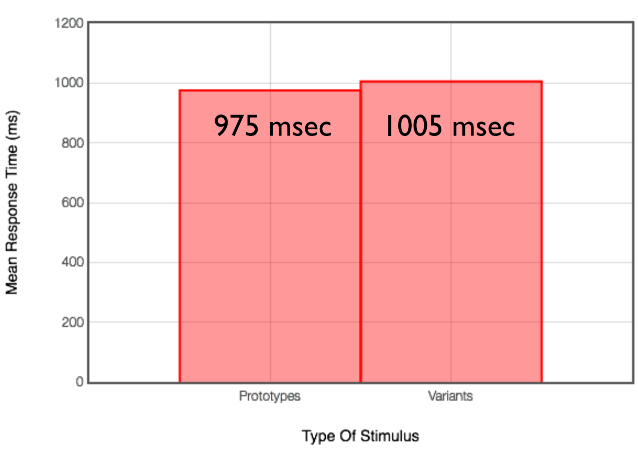
Psychological Essences

- Members of category all have same "essence" (invisible but important "ness")
- Examples:
  - Does painting stripes on a Horse make it a Zebra?
  - Does painting numbers on a Plate make it into a Clock?

CogLab 7: Prototypes

- Methods:
  - Phase 1: learn to classify two dot patterns (A and B) with feedback
  - Phase 2: classify new set
- Independent Variable
  - Prototypes vs. New Patterns
- Theory
  - can we learn an abstract category based on examples?
  - will RT to the Prototype be faster than to new variations?

CogLab 7: Global Data

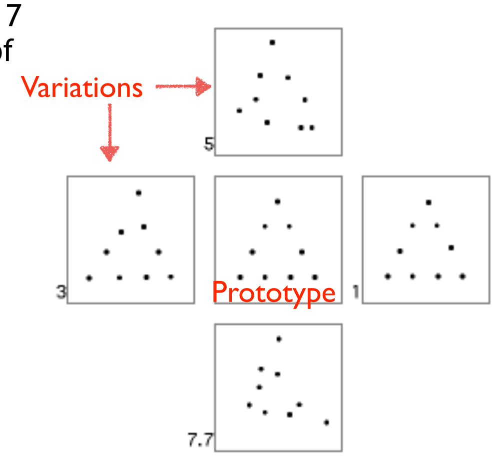


Posner (1968)

- Experiment #3
- Phase 1
  - S's learn pattern A and B
- Phase 2
  - S's tested on variations
- Results
  - RT to prototypes (schema) better than to new variations (2.3s) and closer RT to prior patterns (2.0s) than new variations (2.9)

Posner (1968) Stimuli Examples

- 1, 3, 5 and 7 = amount of distortion added to prototype



Posner (1968)

- "The first and second experiments allow the authors to reject the idea that only the abstracted prototype is stored. Clearly the information about the individual patterns must also be present in order for a loose concept (high variability) to give better transfer than a tight concept (low variability)."

Posner (1968)

TABLE 5

Percentage of Errors and Speeds (in sec.) for Classifying Transfer Patterns for Day 1 and Day 2

	Day 1					Day 2				
	Old	Schema	5	7	New	Old	Schema	5	7	New
List A										
% Error	10	13.3	23.3	35	—	9.7	14.4	24.1	36	—
RT	2.04	2.19	2.36	2.52	2.88	1.86	1.88	2.03	2.18	2.51
List B										
% Error	16.1	16.6	30.5	41.7	—	15.8	16.1	25.3	46.9	—
RT	1.97	2.37	2.71	3.22	2.95	1.88	2.06	2.12	2.33	2.35
Average % Error	13.0	14.9	26.9	38.3	—	12.8	15.3	24.5	41.9	—
RT	2.01	2.28	2.53	2.87	2.91	1.87	1.97	2.07	2.25	2.43

CogLab 7: Prototypes

- Debriefing
  - Methods
    - differences?
  - Predictions
    - TBD
  - Robust? Limitations?

Clinical Evidence

Category-Specific Semantic Impairment

- Warrington & Shallice (1984)
- Four patients with post-herpes simplex encephalitis
- Task: Identify concrete visual objects
  - inanimate objects: yes
  - living things & food: no
- Patients also had severe global amnesia
- Klüver-Bucy syndrome also seen
  - which includes hyperphagia and pica

Clinical cases

- **Agnosia -** inability to know what an object is
- **Anomia -** inability to name objects (but do know what it is)
- **Aphasia** - inability to speak
  - Receptive aphasia (Wernicke's)
  - Expressive aphasia (Broca's)

- All represent different forms of Semantic Network Disruption