SEMANTICS

IF YOU BELIEVE THAT PEOPLE MAKE THEIR OWN LUCK,
THEN YOU CLEARLY DON'T KNOW WHAT LUCK IS.
Semantic Memory
Learning & Memory
Semantic Memory

• *General knowledge about the world, not linked to any time or context*

Some examples:

• What is the capital of North Dakota?
  • Bismarck

• What is the population of Detroit?
  • ~951,000

• Is a tomato a fruit or a vegetable?
  • Fruit, but it tastes like a vegetable

• What is the easiest way to get a message to your best friend?
  • Text message? Phone call? Email? Letter? Carrier Pigeon?
1. How do our brains organize and store the vast amount of information we learn about geography, history, baseball, etc.?

2. Where is all this information stored and how do we access it?

3. How is new information added to an existing framework?
Hierarchically Organized

Semantic Network Models
- Collins & Qullian (1969)
- Nodes, ISA, and Property Links

Figure 1. Hierarchical network model of semantic memory.
Semantic Network Models

- Collins & Qullian (1969; 1972)
  - Spreading Activation
Category Learning

• Instance Learning Theories
  – Exemplars

• Feature Abstraction Theories
  – Property inheritance (aka Inferential Power)
    • Semantic Network Models

• Prototype Theories
  – (Rosch, 1970)
Aspects of Categorization

- Eleanor Rosch (aka Heider)

![Diagram of categorization levels]
Converging Operations for Basic Level

- Common attributes
- Shape Overlap
- Labeling
- Verification
- Grouping of items by children
More than just categorical hierarchy?

- Miller’s Junkbox Metaphor
- Rips et al. (1973)
  - RTs slower “A dog is a mammal” compared with “A dog is an animal”
- Rosch on *Typicality* and *Family Resemblance*
  - Good examples of a category
    \[ r = 0.89 \pm 0.05 \]
  - Fuzzy Categories (McCloskey & Glucksberg, 1978)
Typicality  
(Rosch & Mervis, 1975)

<table>
<thead>
<tr>
<th>Item</th>
<th>Furniture</th>
<th>Vehicle</th>
<th>Fruit</th>
<th>Weapon</th>
<th>Vegetable</th>
<th>Clothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chair</td>
<td>Car</td>
<td>Orange</td>
<td>Gun</td>
<td>Peas</td>
<td>Pants</td>
</tr>
<tr>
<td>2</td>
<td>Sofa</td>
<td>Truck</td>
<td>Apple</td>
<td>Knife</td>
<td>Carrots</td>
<td>Shirt</td>
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<tr>
<td>3</td>
<td>Table</td>
<td>Bus</td>
<td>Banana</td>
<td>Sword</td>
<td>String beans</td>
<td>Dress</td>
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<tr>
<td>4</td>
<td>Dresser</td>
<td>Motorcycle</td>
<td>Peach</td>
<td>Bomb</td>
<td>Spinach</td>
<td>Skirt</td>
</tr>
<tr>
<td>5</td>
<td>Desk</td>
<td>Train</td>
<td>Pear</td>
<td>Hand grenade</td>
<td>Broccoli</td>
<td>Skirt</td>
</tr>
<tr>
<td>6</td>
<td>Bed</td>
<td>Trolley car</td>
<td>Apricot</td>
<td>Spear</td>
<td>Asparagus</td>
<td>Jacket</td>
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<tr>
<td>7</td>
<td>Bookcase</td>
<td>Bicycle</td>
<td>Plum</td>
<td>Cannon</td>
<td>Corn</td>
<td>Coat</td>
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<td>8</td>
<td>Footstool</td>
<td>Airplane</td>
<td>Grapes</td>
<td>Bow and arrow</td>
<td>Cauliflower</td>
<td>Sweater</td>
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<tr>
<td>9</td>
<td>Lamp</td>
<td>Boat</td>
<td>Strawberry</td>
<td>Club</td>
<td>Brussel sprouts</td>
<td>Underpants</td>
</tr>
<tr>
<td>10</td>
<td>Piano</td>
<td>Tractor</td>
<td>Grapefruit</td>
<td>Tank</td>
<td>Lettuce</td>
<td>Socks</td>
</tr>
<tr>
<td>11</td>
<td>Cushion</td>
<td>Cart</td>
<td>Pineapple</td>
<td>Teargas</td>
<td>Beets</td>
<td>Pajamas</td>
</tr>
<tr>
<td>12</td>
<td>Mirror</td>
<td>Wheelchair</td>
<td>Blueberry</td>
<td>Whip</td>
<td>Tomato</td>
<td>Bathing suit</td>
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<tr>
<td>13</td>
<td>Rug</td>
<td>Tank</td>
<td>Lemon</td>
<td>Icepick</td>
<td>Lima beans</td>
<td>Shoes</td>
</tr>
<tr>
<td>14</td>
<td>Radio</td>
<td>Raft</td>
<td>Watermelon</td>
<td>Fists</td>
<td>Eggplant</td>
<td>Vest</td>
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<tr>
<td>15</td>
<td>Stove</td>
<td>Sled</td>
<td>Honeydew</td>
<td>Rocket</td>
<td>Onion</td>
<td>Tie</td>
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<tr>
<td>16</td>
<td>Clock</td>
<td>Horse</td>
<td>Pomegranate</td>
<td>Poison</td>
<td>Potato</td>
<td>Mittens</td>
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<tr>
<td>17</td>
<td>Picture</td>
<td>Blimp</td>
<td>Date</td>
<td>Scissors</td>
<td>Yam</td>
<td>Hat</td>
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<tr>
<td>18</td>
<td>Closet</td>
<td>Skates</td>
<td>Coconut</td>
<td>Words</td>
<td>Mushroom</td>
<td>Apron</td>
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<tr>
<td>19</td>
<td>Vase</td>
<td>Wheelbarrow</td>
<td>Tomato</td>
<td>Foot</td>
<td>Pumpkin</td>
<td>Purse</td>
</tr>
<tr>
<td>20</td>
<td>Telephone</td>
<td>Elevator</td>
<td>Olive</td>
<td>Screwdriver</td>
<td>Rice</td>
<td>Wristwatch</td>
</tr>
</tbody>
</table>

TABLE 2

<table>
<thead>
<tr>
<th>Category</th>
<th>Most typical members</th>
<th>Least typical members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Vehicle</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>Fruit</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Weapon</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Vegetable</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Clothing</td>
<td>21</td>
<td>0</td>
</tr>
</tbody>
</table>
Converging Operations for Typicality

- Reaction time (RT): Yes/No category judgments
- Development: Naming and identification
- Priming
- Word Frequency

**Figure 1.** Mean proportion of "yes" responses as a function of typicality level.

**Table 2.** Effect of Degree of Typicality on Response Measures (Experiment 1)

<table>
<thead>
<tr>
<th>Stimulus type</th>
<th>Number of errors</th>
<th>Reaction time (msec)</th>
<th>Typicality rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Dot patterns</td>
<td>12.1</td>
<td>14.8</td>
<td>19.8</td>
</tr>
<tr>
<td>Stick figures</td>
<td>7.8</td>
<td>10.3</td>
<td>14.5</td>
</tr>
<tr>
<td>Family resemblance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symmetric</td>
<td>2.1</td>
<td>4.0</td>
<td>5.2</td>
</tr>
<tr>
<td>Asymmetric</td>
<td>1.6</td>
<td>5.9</td>
<td>9.3</td>
</tr>
</tbody>
</table>

*Note.* High, medium, and low refer to degree of typicality.
Prototypes

- A simple model of a category of items that share the basic features of the model
  - Solves Classical View of categories
  - Fuzzy Categories
  - Goal-Directed categories?

(Barsalou, 1983)
Distributed Network Models

- McClelland & Rumelhart (1986)
- Farah & McClelland (1991)
  - Modules & Connections
  - Graceful degradation
Explicit vs. Declarative

- **Spatial Memory** (Moar, 1978)
  - Influenced by experience
  - Reference Systems
    - Egocentric
    - Allocentric (Environmental)
Spatial Memory

• Route vs. Survey
  – All experience-based spatial memories start as route maps (Thorndyke & Hayes-Roth, 1982)
  – Reference Systems

• Distortions in Spatial Memory
  Stevens & Coupe (1978)
  – Further west? San Diego or Reno
  – Further north? Montreal or Seattle
Semantic Memory

NEUROLOGICAL BASES
New Terminology

• Aphasia
  Disorder of language comprehension

• Agnosia
  Inability to identify familiar objects

• Anomia
  Inability to name objects
Category-Specific Naming Deficits

- Living vs. Nonliving Objects (Warrington & Shallice, 1984)
- Double dissociation

<table>
<thead>
<tr>
<th>J.B.R.</th>
<th>Living things</th>
<th>Inanimate objects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visual Identified</td>
<td>Named</td>
</tr>
<tr>
<td>J.B.R. (58.80)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>S.B.Y. (27.82)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Percentage correct identification score, naming score and superordinate score.

J.B.R.:
- Parrot—don’t know.
- Daffodil—plant
- Snail—an insect animal.
- Eel—not well.
- Ostrich—unusual.

S.B.Y.:
- Duck—an animal.
- Wasp—bird that flies.
- Crocus—rubbish material.
- Holly—what you drink.
- Spider—person looking for things, he was a spider for a nation or country.

J.B.R.:
- Tent—temporary outhouse, living home.
- Briefcase—small case used by students to carry papers.
- Compass—tools for telling direction you are going.
- Torch—hand-held light.
- Dustbin—bin for putting rubbish in.

S.B.Y.:
- Wheelbarrow—object used by people to take material about.
- Towel—material used to dry people.
- Pram—used to carry people, with wheels and thing to sit on.
- Submarine—ship that goes underneath sea.
- Umbrella—object used to protect you from water that comes.
Category-Specific Naming Deficits

• Somatic Marker Hypothesis
  – Damasio et al. (1996)
Prosopagnosia

- Ventral Temporal Cortex
  - Fusiform Face Area (FFA)
- Farah, Levinson, & Klein (1995)
Parahippocampal Place Area (PPA)

- fMRI Signal Change in PPA (Epstein & Kanwisher, 1998)
Extrastriate Body Area (EBA)

• Right Lateral Occipital Cortex (Downing et al., 2001)

Fig. 2. Stimulus examples. The EBA response was high to human body parts (A) and whole human bodies (B) whether presented as photographs, line drawings (C), stick figures (D), or silhouettes (E), and was not attenuated to images that depict little implied motion (F). The low response to whole faces (G) was the single exception found to the preference for human bodies. In contrast, the EBA response was significantly lower to object parts (H) and whole articulated objects (I), whether represented as photographs or line drawings (J), as well as to scrambled control versions of stick figures (K) and silhouettes (L). The responses to face parts (M) and to mammals (N) were intermediate.
Localization

• of Function or Process?

• Semantic Memory is broadly represented
  – Different processing demands for different categories (Martin et al., 1996)
Distributed Processing

- Greebles again!
- Novices vs. Experts
- Categorizing families (object recognition) vs. individuals (FFA)
  - FFA distinguishes between individuals of a category
  - Broad network of semantic memories
Creating Semantic Memories

- Remember to Know Shift (Rajaram, 1993)
  - Episodic to Semantic Shift
- Hippocampus and Relational Networks (Eichenbaum et al., 1999)
Amnesics

- **Artificial Grammar** (Knowlton et al., 1992)
  - Can still learn some semantic memories?

![Diagram of artificial grammar](image)
Amnesics and Peggles

- Categorization using a prototype (A)
  - General Rules (Reed et al., 1999)
Hippocampus and Semantic Memory

• Some say it’s hot (Maguire & Frith, 2004)
  – fMRI: Hippocampus (and others) active when learning facts

Fig. 1. Comparison of fact acquisition with the baseline task. Activations are shown on appropriate sagittal, coronal, and transverse sections from the averaged structural MRI scan of the subjects. The activations shown here: top left and top right panels, left hippocampus; top right panel, left middle temporal gyrus, medial dorsal nucleus of the thalamus; bottom left panel, left ventrolateral prefrontal cortex; bottom middle panel, medial dorsal nucleus of the thalamus; bottom right panel, left dorsolateral prefrontal cortex, left temporoparietal junction (see also Table 1).
Hippocampus and Semantic Memory

• Some say it’s not (e.g., O’Kane et al., 2004)
  – H.M. moved in 1958 and 1974
  – Memory for home in 1966
  – Famous people
Evidence for Binding of Memories

- Transitive Inference (e.g., Preston et al. 2004)
Evidence for Binding of Memories

• E.P.’s MTL damage (Bayley & Squire, 2002)
  – Learning 3-word sentences
    • Standard Test: Recognition and Cued Recall
      “SPEECH caused LAUGHTER” vs. “SPEECH caused ???”
    • Synonym Test: “VENOM caused” to “VENOM induced”
Summary

• Hierarchically Organized
  – Typicality, Prototypes
• Semantic and Distributed Network Models
• Category-Specific Naming Deficits
  – FFA, PPA, EBA
• Distributed Representation vs. Processing
• Amnesics
• Hippocampus and Binding of Episodic Memory