The Origin of Words

- When did you first learn the word ‘hater’?
- Do you know its meaning separate from your memories of when you heard the word?
- What does it mean? List the properties of someone who is a ‘hater’
- Is it always clear when someone is or is not a ‘hater’?
- Can you list a perfect example of someone who is a ‘hater’?
- When is someone a ‘hater’ and when are they just ‘mean’?
General Knowledge

• “concepts” and “semantic memory”
  – static representation and interrelationships
    • reaction time experiments (retrieval)
      – sentence verification
      – lexical decision

• “categorization”
  – the assignment of specific examples to concepts
    • Learning and category boundaries
    • accuracy experiments (classification)
Classical View
(rule based)

• list of necessary and sufficient features
• examples
  – Prime number: integer, only divisible by 1 and itself
  – Triangle: closed, 3-sided figure
  – Bachelor: male, adult, unmarried, human
• assumes
  – representation through feature lists
  – membership is clear-cut (are bookends furniture?)
  – no such thing as “better” and “worse” examples

<table>
<thead>
<tr>
<th>EVEN NUMBER</th>
<th>ODD NUMBER</th>
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<tbody>
<tr>
<td>Stimulus</td>
<td>Typicality Rating</td>
</tr>
<tr>
<td>4</td>
<td>5.9</td>
</tr>
<tr>
<td>8</td>
<td>5.5</td>
</tr>
<tr>
<td>10</td>
<td>5.3</td>
</tr>
<tr>
<td>18</td>
<td>4.4</td>
</tr>
<tr>
<td>34</td>
<td>3.6</td>
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<td>106</td>
<td>3.1</td>
</tr>
</tbody>
</table>
Hierarchical Semantic Network

- **subordinate** and **superordinate** nodes
- **cognitive economy**
non-Hierachical Networks

• Same action at different levels (no difference)
  – “a shark can move”, “a fish can move”, “an animal can move”

• the typicality effect
  – “a robin is a bird”
  – “a turkey is a bird”

• Spreading Activation (Collins and Loftus, 1975)
  – not hierarchical
  – not economical
  – weighted links and distance
    • association strength
    • directional links
Prototype Theory

• idealized best instance
  – doesn’t have to exist
  – includes characteristic features

• resemblance to prototype
  – Typical: many characteristic features
    • Robin
      – small, flies, eats worms, lives in tree
  – Atypical: few characteristic features
    • the Pope
      – not young, doesn’t live in an apartment
Support for Prototype Theory

- Posner and Keele random dot study
- Rosch and Mervis
  - list features of objects
    - chair, desk, apple, etc.
  - list features of categories
    - furniture, fruit, etc.
  - objects sharing features with category were more typical
  - category feature lists did not work for all objects
    - classical view doesn’t work

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Rating</th>
<th>Bird</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>6.25</td>
<td>Robin</td>
<td>6.89</td>
</tr>
<tr>
<td>Peach</td>
<td>5.81</td>
<td>Bluebird</td>
<td>6.42</td>
</tr>
<tr>
<td>Pear</td>
<td>5.25</td>
<td>Seagull</td>
<td>6.26</td>
</tr>
<tr>
<td>Grape</td>
<td>5.13</td>
<td>Swallow</td>
<td>6.16</td>
</tr>
<tr>
<td>Strawberry</td>
<td>5.00</td>
<td>Falcon</td>
<td>5.74</td>
</tr>
<tr>
<td>Lemon</td>
<td>4.86</td>
<td>Mockingbird</td>
<td>5.47</td>
</tr>
<tr>
<td>Blueberry</td>
<td>4.56</td>
<td>Starling</td>
<td>5.16</td>
</tr>
<tr>
<td>Watermelon</td>
<td>4.06</td>
<td>Owl</td>
<td>5.00</td>
</tr>
<tr>
<td>Raisin</td>
<td>3.75</td>
<td>Vulture</td>
<td>4.84</td>
</tr>
<tr>
<td>Fig</td>
<td>3.38</td>
<td>Sandpiper</td>
<td>4.47</td>
</tr>
<tr>
<td>Coconut</td>
<td>3.06</td>
<td>Chicken</td>
<td>3.95</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>2.50</td>
<td>Flamingo</td>
<td>3.37</td>
</tr>
<tr>
<td>Avocado</td>
<td>2.38</td>
<td>Albatross</td>
<td>3.32</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>2.31</td>
<td>Penguin</td>
<td>2.63</td>
</tr>
<tr>
<td>Olive</td>
<td>2.25</td>
<td>Bat</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Ratings were made on a 7-point scale, with 7 corresponding to the highest typicality. Note also that the least “birdy” of the birds isn’t (technically speaking) a bird at all! (After Malt & Smith, 1984.)
Basic Level Categories
(Rosch et al., 1976)

- The goal of categorization is to
  - group together things that are similar
  - distinguish between different groups
  - need to compromise between these goals
- Members of basic-level categories are
  - similar to each other
  - dissimilar from other categories

<table>
<thead>
<tr>
<th>Superordinate</th>
<th>Basic Level</th>
<th>Subordinate</th>
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</thead>
<tbody>
<tr>
<td>Musical instrument</td>
<td>Guitar</td>
<td>Classical guitar, Folk guitar</td>
</tr>
<tr>
<td></td>
<td>Piano</td>
<td>Grand piano, Upright piano</td>
</tr>
<tr>
<td></td>
<td>Drum</td>
<td>Bass drum, Kettle drum</td>
</tr>
<tr>
<td>Fruit</td>
<td>Apple</td>
<td>Delicious apple, McIntosh apple</td>
</tr>
<tr>
<td></td>
<td>Peach</td>
<td>Cling peach, Freestone peach</td>
</tr>
<tr>
<td></td>
<td>Grapes</td>
<td>Concord grapes, Green seedless grapes</td>
</tr>
</tbody>
</table>
Prototypes Cont.

• Successes
  – explains typicality
    • even for well-defined categories (3 versus 57)
  – explains hard to define concepts
  – handles irregular items such as tomatoes

• Failures
  – How to define boundaries?
  – Resemblance depends on context
    • Birds in the open plains versus backyard
  – Sensitivity to particular exemplars
Exemplar Theory

• examples are stored rather than prototype or rule
  – match new instance to stored exemplars
    • category defined by single best matching exemplar OR
    • category defined by summed match

• too unconstrained?
  – computational models with specific storage and retrieval rules

• a comparison of rule, prototype, and exemplar models
  – Different decision boundaries in a well defined similarity space
Support for Exemplar Theory

• Classic study by Shepard et al. (1961)
  – can’t be explained by rule or prototype theory
  – can be explained by exemplar models
Resemblance vs. Function

• Exemplar/Prototype theories assume categorization by resemblance
  – But what about a perfect counterfeit bill?

Spotting a Counterfeit Bill
Here are some basic tips for spotting counterfeits

1. Security Threads
   - blue and orange strands of paper

2. Watermark

3. Color-shifting Ink
Difficulties with Resemblance

• Children were asked
  – Can you turn a skunk into a raccoon?
    • “It has a raccoon mommy and daddy . . .”
  – Can you turn a toaster into a coffeepot?
    • “Just need to poke some holes in it . . .”
• The Knowledge-Based View
  – how the world works (not resemblance)
    • Grouping by similar function
    • on-the-fly categories
      – children, pets, photos, heirlooms

• Psychological Essentialism
  – The essence of (underlying reason for) the category matters
    • nominal categories (rule-based, classical view)
    • natural-kind categories (complex, prototype/exemplar view)
    • artifacts (serve a function, knowledge-based view)
  – Experiment with natural-kind objects and artifacts
    • imagine certain transformations
      – functional transformations
        » a TV with no picture
        » a dog that can’t bark
      – molecular transformations
        » a TV made out of stone
        » a dog made out of plastic
Propositional Networks
(relationships between concepts)

- Adaptive Control of Thought (ACT, *, -R) – Anderson (1976, 1983) – a cognitive architecture
  - episodic and semantic = declarative (conscious) memory
    - consists of propositions
  - procedural memory
    - production rules
  - working memory
  - ACT-R home page
Concepts are Distributed throughout the Brain (patients with anomia)
Parallel Distributed Processing (PDP) / Connectionism / Neural Network

<table>
<thead>
<tr>
<th>Name</th>
<th>Major</th>
<th>Year</th>
<th>Political Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joe</td>
<td>Art</td>
<td>Junior</td>
<td>Liberal</td>
</tr>
<tr>
<td>Marti</td>
<td>Psychology</td>
<td>Sophomore</td>
<td>Liberal</td>
</tr>
<tr>
<td>Sam</td>
<td>Engineering</td>
<td>Senior</td>
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<tr>
<td>Liz</td>
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</tr>
<tr>
<td>Roberto</td>
<td>Psychology</td>
<td>Senior</td>
<td>Liberal</td>
</tr>
</tbody>
</table>
A PDP model for sentence verification