Cognitive Psychology: Conceptual Knowledge

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Announcement

- Project progress report is officially due today.
  1. A high-quality introduction of the issue and the background,
  2. a precise summarization of one paper/book chapter in your project readings,
  3. a very brief description of what you will do next.
- If you cannot finish the task before the official due date, you can automatically extend the deadline up to 5 days.

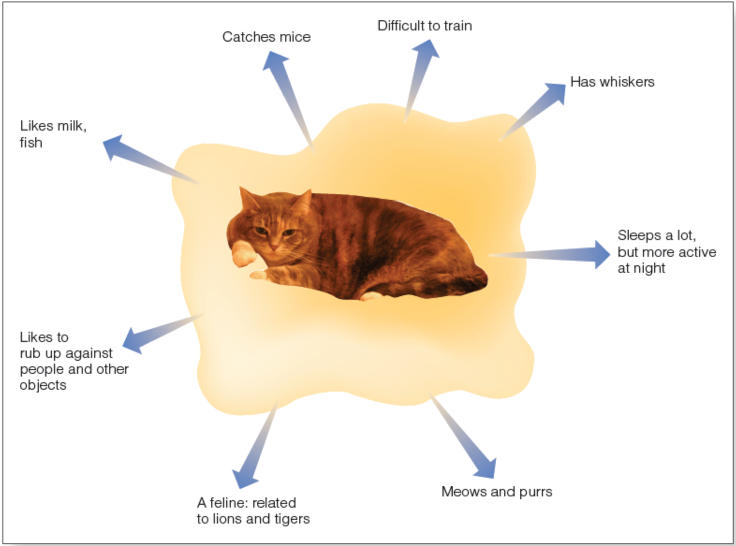
Conceptual Knowledge

- A concept is a mental representation used for a various types of cognitive functions: e.g. memory, language, reasoning, etc.
- You can think of a concept as an unit of knowledge, so you may have a concept of a car or a concept of a bird or that of a human being, a teacher, a student etc.
- Concepts help us categorize the world. For example, when you look around, you might find the world filled with objects and scenery of all kinds, however, you are able to carve that into a person, an animal, a farm, or even more specific concepts like John, John's dog, and John's farm.

Category

- A category includes all possible examples of a particular concept. Concepts provide the rules for creating categories.
- Categories are essential for us to have an understanding of the world.
- An important function is to help us in understanding individual exemplars, which we have never come across before, on the basis of knowing their category.
- Hence categories have also been refered to as "pointers of knowledge" (Yamauchi and Markman, 2000). For example once you know that an exemplar belongs to a certain category, you can infer a lot.

Categories as Pointers of Knowledge



How are Objects Categorized?

- Definitional approach: whether a particular object meets the definition of the category.
- Definitions work for some things, such as geometric objects. Thus, defining a triangle, as composed 3 intersecting lines which may or may not be equal, may be helpful. However, for many cases definitions do not work well at all.

Wittgenstein on Definitions

- An interesting insight on the problem of definition was shared by Wittgenstein (1953)
- Consider for example the proceedings we call "games." I mean board-games, card-games, ball-games, Olympic games, and so on. For if you look at them you will not see something in common to all, but similarities, relationships, and a whole series of them as that. I can think of no better expression to characterize these similarities than "family resemblances."

Categories as Pointers of Knowledge


(a) (b) (c) (d)

Wittgenstein on Definitions

- The idea of family resemblances refers to the idea that things in a particular category resemble one another in a number of ways.
- So, instead of putting up a hard definition to which all members of a category would match, the familiar resemblance idea allows for variations within the members.
- Drawing on the idea of family resemblances; psychologists have proposed that categorization is achieved on the basis of determining crucial similartities among objects; that conform to some standard representation but can vary around a bit.

Outline

Prototype Approach to Categorization

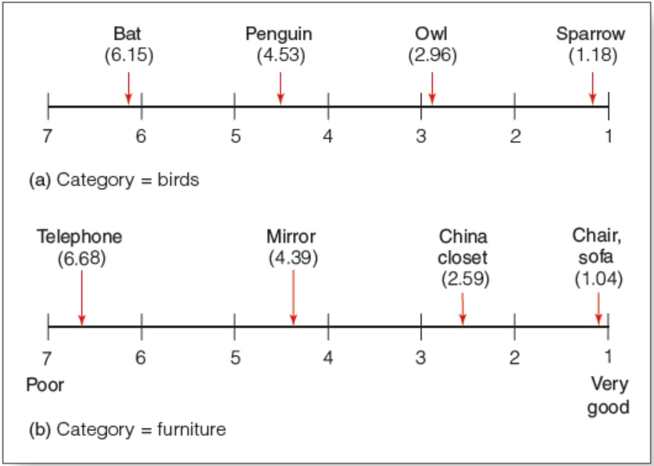
- Proposes that category memberships are determined by comparing possible exemplars to a prototype, i.e. a typical member of the category.
- Eleanor Rosch (1973) proposed that the "typical" prototype is based on an average of members of a category that are commonly experienced. For example, the prototype for the category "birds" might be based on some of the birds you usually see, such as sparrows, robins, and blue jays, but doesn't necessarily look exactly like any one of them, and is just an "average" representation of the category.

Categories as Pointers of Knowledge

Prototype Approach to Categorization

- Rosch describes these variations within categories as representing differences in typicality.
- High typicality means that a category member closely resembles the category prototype (it is like a "typical" member of the category).
- Low typicality means that the category member does not closely resemble a typical member of the category.
- Rosch (1975a) quantified this idea by presenting participants with a category title, such as "bird" or "furniture," and a list of about 50 members of the category.

Rosch's Measurement of Typicality



Characteristics of Prototypical Objects

- Rosch and Mervis showed that there is a strong relationship between family resemblance and prototypicality, because items high on prototypicality also had high family resemblance.
- For example, chair and sofa belong to the category furniture have both high prototypicality and high family resemblance.

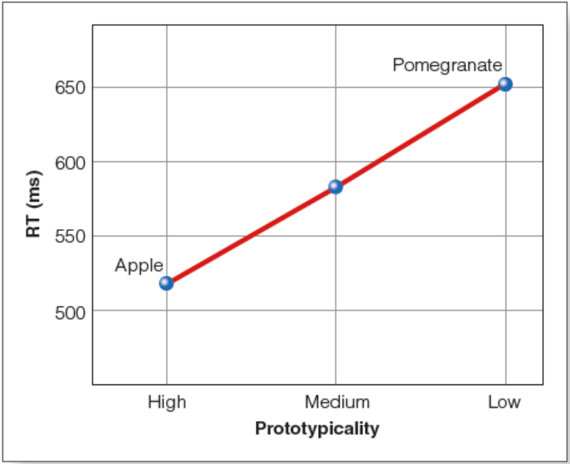
Statements About Prototypical Objects Are Verified Rapidly

Edward Smith and coworkers (1974) used a procedure called the sentence verification technique to determine how rapidly people could answer questions about an object's category.

- An apple is a fruit.
- A pomegranate is a fruit.

They found that participants responded faster for objects that are high in prototypicality (like apple for the category "fruit") than they did for objects that are low in prototypicality.

Smith's Sentence Verification Experiment



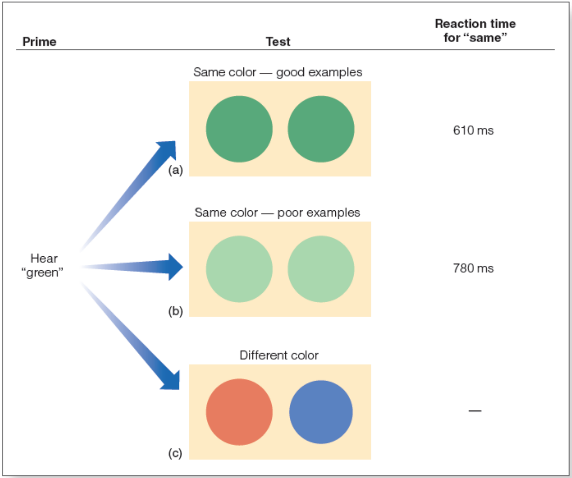
Prototypical Objects Are Named First

When participants are asked to list as many objects in a category as possible, they tend to list the most prototypical members of the category first (Mervis et al., 1976). Thus, for “birds,” sparrow would be named before penguin.

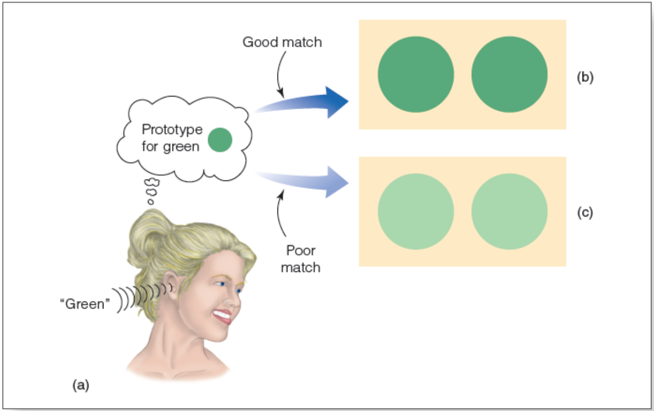
Prototypical Objects Are Affected More by Priming

- Rosch (1975b) demonstrated that prototypical members of a category are more affected by a priming stimulus than are nonprototypical members.
- Rosch explains the findings as, when the participants hear the word “green” as prime, they imagine a good (highly prototypical) green; which in turn facilitates the participant’s response to a stimulus that matches the high prototype.

Rosch's (1975b) Priming Experiment



Rosch's (1975b) Priming Experiment



Outline

1. Prototype Approach to Categorization
2. **The Exemplar Approach**
3. Semantic Networks
4. Embodiment

The Exemplar Approach: Thinking About Examples

- Involves determining whether an object is similar to a standard object.
- However, whereas the standard for the prototype approach is a single "average" member of the category; the standard for the exemplar approach involves many examples, each one called an exemplar.
- Exemplars are actual members of the category that a person has encountered in the past.

Prototypes and Exemplars

- One advantage of the exemplar approach is that by using real examples, it could be possible more easily to take into account atypical cases such as flightless birds. For example, rather than comparing a penguin to an average bird, one would compare it to other flightless birds that one might have come across.
- Also, it might be difficult to have prototypes for a category that has football, cricket, computer games etc., the exemplar approach only requires us to remember some of the different kinds of examples.

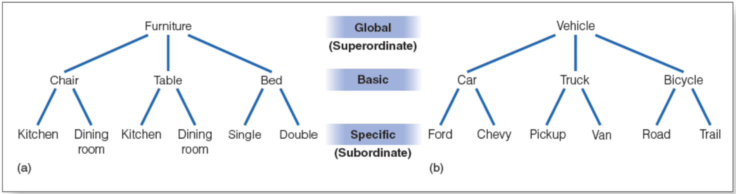
Prototypes and Exemplars

- Some researchers have proposed that people may be using both approaches.
- We might be initially averaging exemplars into a prototype; but as we become more familiar with the category we might start using exemplar information more and more(Keri et al., 2002).
- So, early in learning we would be poor at taking into account exceptions such as ostriches or penguins, but later exemplars for these cases would be added to the category.
- Other researchers have suggested that the exemplar approach may work best for small categories, such as "Indian Cricket Team Captains". The prototype approach may work best for larger categories, such as "bird".

Is There a Psychologically "Basic" Level of Categories?

If you look at the various exemplars or prototypes of various categories, one would see that these may be divided into general and then more specific categories. For example, a dog or a human can come under the broad general category of animals; but there could be more specific categories as well as mammals.

Levels of Categories



Levels of Categories

LEVEL	EXAMPLE	NUMBER OF COMMON FEATURES
Global	Furniture	3
Basic	Table	9
Specific	Kitchen table	10.3

Lose a lot of information.

Gain just a little information.

Outline

Semantic Networks

- The semantic networks approach is an approach to specify the organization of concepts in the mind; it proposes that concepts are arranged in networks.
- Collins and Quillian (1969) proposed a semantic network, where each network consists of nodes connected by links.
- Each node represents a category or a concept, and concepts are placed in the network so that related concepts are connected. Also, properties associated with each concept are indicated at the nodes.
- The links connecting the nodes indicate that they are related to each other in the mind.

Semantic Networks

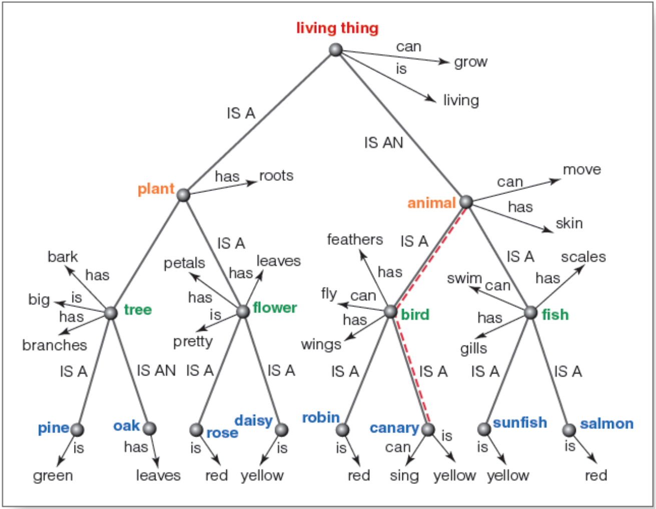
This is a hierarchical model consisting of levels arranged so that more specific concepts, such as "canary" are at the bottom, and the more general concepts are at high levels.

Semantic Networks

How does this work?

- Suppose you enter the network at any possible concept node, say canary. If you want to know more about the concept, you move up one level to discover that it is a bird and things like "has feathers" and "can fly". If you want to know more specific things about the canary you might want to move a level down to find out that it is yellow in color.

Collins and Quillian's (1969) Semantic Network



Semantic Networks

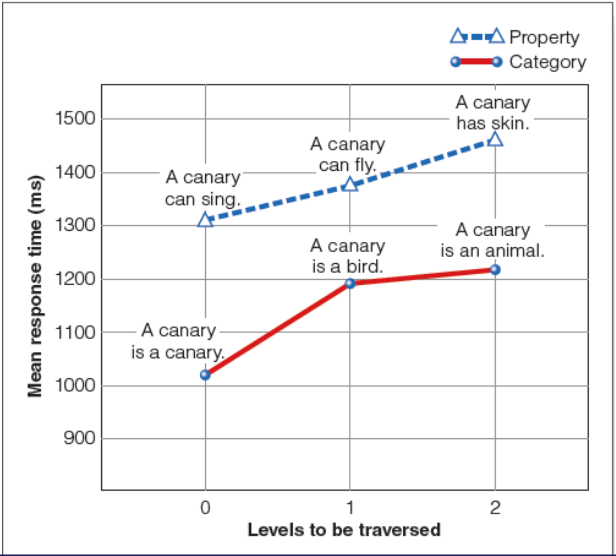
How do the elements of a semantic network correspond to the actual working of the brain?

- The links and nodes in the network may not necessarily correspond to the specific locations in the brain; but the concepts and their properties are associated in the brain.
- Also, physiological findings relevant to these models, such as neurons that respond best to specific categories were not available until many years after these models were proposed.
- Not withstanding the neural connections, it can be asked however, whether the Colins and Quillian's model represents how concepts are actually organized in the mind.

Semantic Networks

- One prediction is that the time it takes for a person to retrieve information about a concept should be determined by the distance that must be traveled through the network.
- Thus, the model predicts that when using the sentence verification technique, in which participants are asked to answer "yes" or "no" to statements about concepts, it should take longer to answer "yes" to the statement "A canary is an animal" than to "A canary is a bird."

Results of Collins and Quillian's (1969) Experiment



Criticism of the Collins and Quillian Model

- The theory couldn't explain the typicality effect, in which reaction times for statements about an object are faster for more typical members of a category than for less typical members (Rips et al., 1973)
- Thus, the statement "A canary is a bird" is verified more quickly than "An ostrich is a bird," but the model predicts equally fast reaction times because "canary" and "ostrich" are both one node away from "bird."

Criticism of the Collins and Quillian Model

Lance Rips and coworkers (1973) obtained sentence verification results such as the following:

- A pig is a mammal. RT = 1,476 ms
- A pig is an animal. RT = 1,268 ms

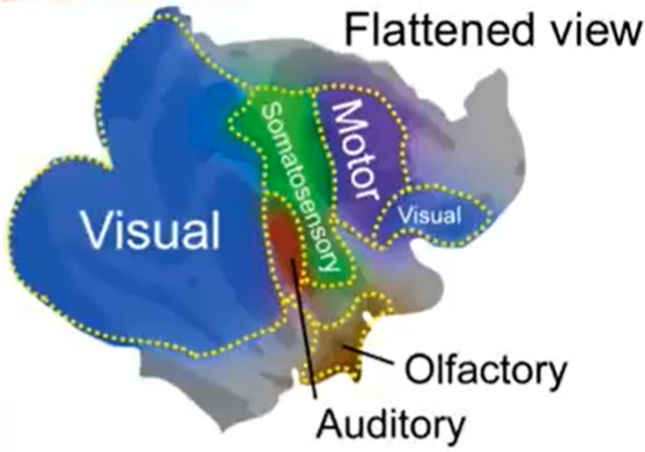
Outline

What is Thought?

Insight: neurons rarely do one thing!

- Sensory + Motor
- Tactile + auditory
- Vision + Memory
- Responses vary with attention
- Payoff for task performance

Example: Thermostat



Neurons Have Double Duty

Insight: there is overlap between "cognitive" and sensory/motor function

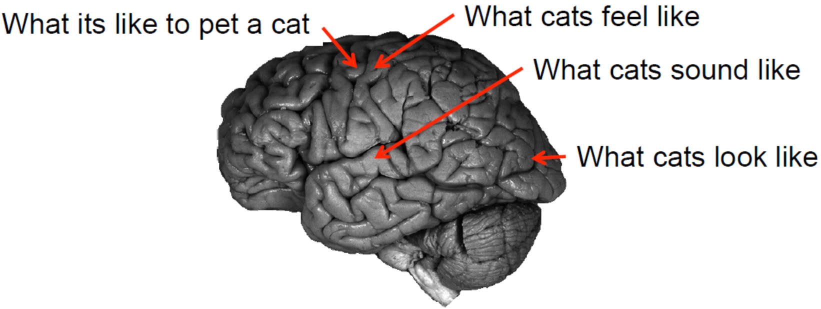
- Solely "cognitive" areas have not been found
- Lesions may produce attentional (e.g. parietal cortex) or memory deficits (e.g. hippocampus, parietal cortex)
- But the neurons in these structures respond in conjunction with sensory and motor events

Theory: Embodied/Grounded Cognition

What Happens When We Think?

- "Simulate" sensory and motor features related to the concept
- For example, when we think of the concept "cat"...

Theory: Embodied/Grounded Cognition



Reference

- E. Bruce Goldstein. (2019) *Cognitive Psychology*, 5th Edition. Cengage Learning, Inc.
- Jennifer M. Groh. (2014) *Making Space: How the Brain Knows Where Things Are*, Harvard University Press.